Finishing Rules Handbook for Sheet Metal

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ABSTRACT: This handbook summarizes design guidelines from a Manufacturing perspective for the selection of the finish to be used in the design of sheet metal parts.

APPLICABILITY: This handbook applies to Digital engineers who design or manufacture sheet metal components.

STATUS: APPROVED 12-JUL-1991; use VTX SMC for current status.

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CHAPTER 1

INTRODUCTION

1.1 PURPOSE

This handbook summarizes design principles, guidelines, and information concerning the finishing of sheet metal components, and is intended to be used when designing components made of sheet metal. These rules have been created so that engineers and designers can design sheet metal parts with the manufacturing process in mind. The intent was also to aid in the selection of a finish to achieve design requirements, while maintaining manufacturing goals.

1.2 SCOPE

This handbook applies to features of sheet metal parts, which have an impact on finish requirements or processes. It also aids in the selection of a finish to achieve design requirements, and ensures manufacturability. It is not intended to identify all manufacturability issues, but to address the most common, and to provide guidance along with some reasoning. It is intended to complement the efforts of producibility /manufacturing engineers in the area of design and manufacturing.

1.3 RESPONSIBILITIES

The Finishing Rules Group is responsible for the content of this handbook. Changes must be approved by this group prior to incorporation into the handbook, Comments and proposed changes should be sent to the owner of the document. The following team created the initial issue of this handbook.

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Les Pitcher

1.4 STRUCTURE OF DESIGN INFORMATION

General Description

Chapter 1—Introduction

The finish design information contained in this handbook takes the form of rules organized in a hierarchy of features and considerations. The hierarchy used to organize the rules provides a guide for users to locate appropriate information within this handbook. The text of the rules is uniformly formatted, and illustrations are included to aid in using and interpreting each rule.

Chapter 2—Low Carbon Steel

Chapter 2 covers finish design and low carbon steel. These categories and feature types should support most engineering requirements for finishing sheet metal and will support future Artificial Intelligence (AI) tool development, such as, The Design Advisor.

Future chapters will address additional sheet metal substrates, such as, aluminum and stainless steel.

1.5 HANDBOOK HIERARACHY

```
Technology (volume)-----------Metals

Process (book)----------------Sheet metal

Material (chapter)------------Low carbon steel

Feature class (section)-------Holes, bends, and so on

Design rule (specific rules)--Hole to bend, and so on
```

1.5.1 Rule Format

The following format has been used in the creation of the Finishing for Sheet Metal rules.

```
-----------------------------------------------------------------
CHAPTER: Basic process classification to which the rule
         applies (example, Low Carbon Steel)
=================================================================
FEATURE: The feature or consideration about which each rule
         provides information (for example, stainless steel)
-----------------------------------------------------------------
RULE CATEGORY: Each rule falls under one of the following
               categories.
PRINCIPLE--Design rules that should not be broken.
GUIDELINE--Design rules that direct the user to the optimun
           solution.
INFORMATION--General knowledge concerning a specific feature.
-----------------------------------------------------------------
RULE:  The limitations, considerations, and other information
       specific to the feature at hand.
-----------------------------------------------------------------
REASON/S:  The underlying fact or cause that provides the
           logic for the rule.
-----------------------------------------------------------------
ALTERNATIVE/S: Provides a design choice outside the limits of
               the rule.
-----------------------------------------------------------------
ALTERNATIVE IMPACT:  The effect(s) of using the alternative
                     rather than following the prescribed rule.
```

1.5.2 Defining the Rule

The sheet metal design rules are used to describe how and why design choices are, or should be, made. The rules are divided into the following categories.

GUIDELINE	Design rule that directs the user to the **OPTIMUM SOLUTION**
INFORMATION	Provides knowledge derived from study, experience, or standards....**FACTS**

CHAPTER 2

LOW CARBON STEEL

2.1 FINISHING PROCESS—FEATURE REQUIREMENTS OVERVIEW

INFORMATION

RULE/S:

1. Feature requirements within the finishing process will be divided into the following major categories (see Figure 2–1):
   - Cosmetics
   - Shielding
   - Corrosion protection
   - Wearability
2. These major categories will be divided into the following major feature types: (see Figure 2–1)
   - Paint
   - Plating
   - Special coatings

   NOTE: Finishing of sheet metal material is an environmental concern subject to regulatory control.

REASON: These categories and feature types should support most engineering requirements for finishing sheet metal, and will support future artificial intelligence (AI) tool development, for example, The Design Advisor.

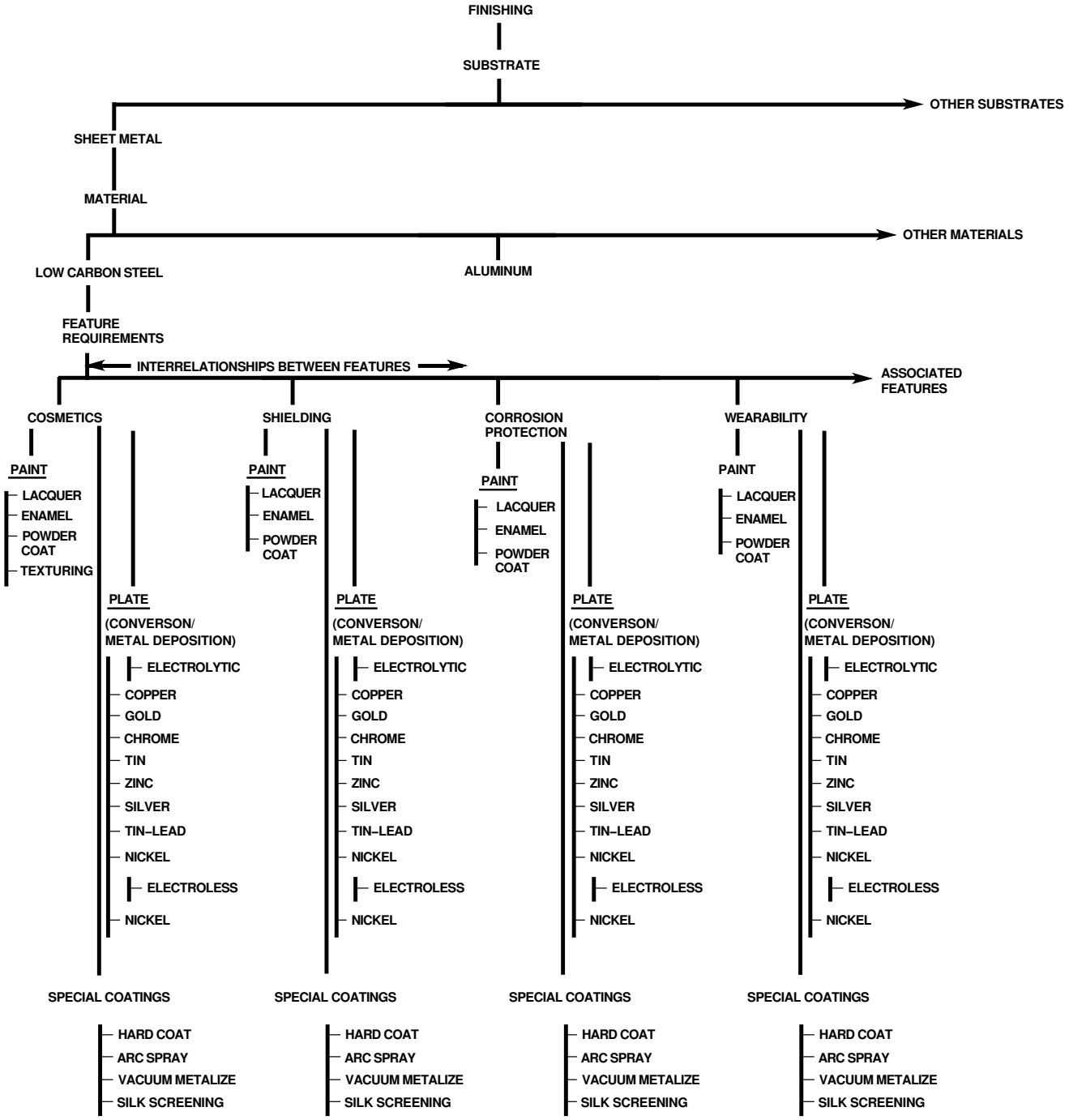
ALTERNATIVE:

Not applicable

ALTERNATIVE IMPACT:

Not applicable

Figure 2–1: Finishing Architecture



2.2 FINISHING—COSMETIC

2.2.1 PAINT/PLATE/SPECIAL COATINGS

INFORMATION

RULE/S:

1. Painting is a finishing option when the following criteria must be met:
   - Precoated sheet metal is *not* available or appropriate.
   - Product uniformity is required.
   - Multicolored part requires painting.

     NOTE: Transition features are difficult to produce in sheet metal, therefore, multicolored piece parts should be avoided.
   - Custom color is a requirement.
2. Plating is a finishing option when a metal-like appearance (such as chrome) is desired.

   NOTE: Plated finishing tends to highlight base material surface imperfections.

   Generally, it is more cost-effective to *paint* as opposed to *plate*.
3. Special coatings is a finishing option when special surface conditions, such as graphics, must be met.

REASON/S:

- Painting or plating of sheet metal are acceptable standard manufacturing processes readily available over a large vendor base.
- Special coatings are developed to satisfy special surface conditions that cannot be satisfied through the use of standard painting and/or plating materials. See a Producibility Engineer for specific design requirements.

ALTERNATIVE/S:

- Prefinished materials
- Other base materials, such as, stainless steel

ALTERNATIVE IMPACT: Precoated material has limited availability in both colors and textures. See a Producibility Engineer for specific design recommendations.

2.2.2 PAINT

INFORMATION

RULE: Features within the paint process will be divided into the following categories. The order of recommended use is:

- Enamel
- Lacquer
- Powder coat (not recommended)

  NOTE: Refer to *DEC STD 092-0 Finish and Color Standard—Introduction and General Requirements* for more specific information.

REASON/S:

- The relative ranking is based upon cost, technical expertise, and available or approved vendor base.
- These feature categories should support most engineering requirements for finishing (painting) sheet metal and will support future AI tool development, for example, The Design Advisor.
- Powder coating is not recommended since there is a limited knowledge base (in Digital) to adequately support the proper use of this process. Also, the powder coat process has a limited vendor base, and texturing per DEC STD 092 cannot be achieved by means of the powder-painting process.

ALTERNATIVE/S:

- Prefinished materials
- Plating
- Special coatings
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT:

Not applicable

2.2.3 PAINT—ENAMEL/LACQUER

GUIDELINE

RULE:

1. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–2.
2. Primer coat(s) may be required to satisfy proper coverage and adhesion. See a Producibility Engineer for specific design recommendations.
3. Lacquers are generally used for prototype development and not volume manufacturing.
4. Enamels are recommended for most cosmetic applications.

REASON/S:

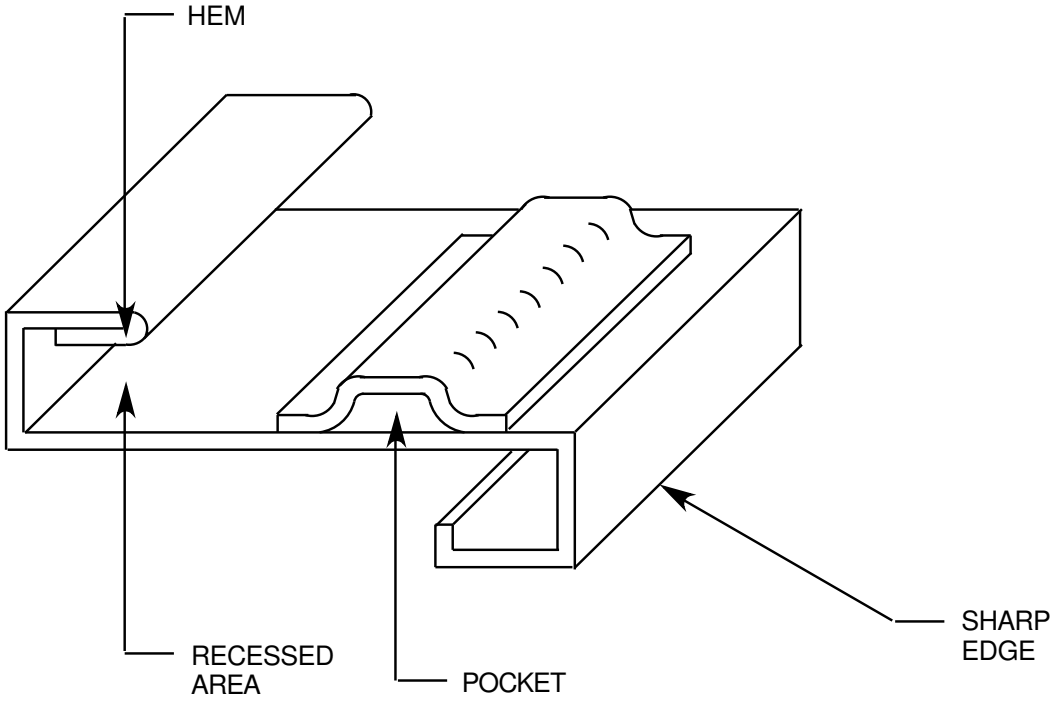
- Enamels and lacquers are applied using a spraying process (not submersion) in most applications.
- Pretreatment Process may require good part drainage characteristics.
- Enamels and lacquers have good coverage capabilities.
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–2.

ALTERNATIVE/S:

- Special coatings
- Prefinished materials
- Other base materials, such as stainless steel
- Plating, such as electrolytic chrome

ALTERNATIVE IMPACT: Positive or negative impact of the alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–2: Paint—Enamel/Lacquer



2.2.4 PLATE

INFORMATION

RULE: Features within the plating process will be divided into the following categories. The order of recommended use is:

- Chrome
- Nickel (not recommended)
- Gold (not recommended)
- Silver (not recommended)
- Copper (not recommended)
- Electroless plating (not recommended)
- Black chrome (not recommended)
- Tin (not recommended)
- Tin-lead (not recommended)
- Zinc (not recommended)

REASON/S:

- The relative ranking is based upon appearance and available or approved vendor base.
- Nickel, copper, electroless plating, tin, tin-lead, and zinc are susceptible to surface discoloration (such as, fingerprints, tarnishing).
- Gold and silver are expensive plus susceptible to surface discoloration (tarnish).
- Black chrome has a limited vendor base.
- These feature categories should support most engineering requirements for finishing (plating) sheet metal and will support future AI tool development, for example, The Design Advisor.

ALTERNATIVE/S:

- Paint
- Prefinished materials
- Other base materials, such as stainless steel
- Special coatings

ALTERNATIVE IMPACT: Positive or negative impact of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.2.5 PLATE—ELECTROLYTIC

INFORMATION

RULE/S:

1. Electrolytic plating is a finishing process with the following characteristics:
   - May require a copper undercoat for adhesion
   - Preferred for thick coating applications
   - Has bright finish capabilities
   - May have poor paint adhesion capabilities
   - Has size constraints (such as, large parts may be difficult to plate).
   - Generally less susceptible to surface discoloration (such as, fingerprints) than electroless plating.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage.

   NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- Process produces a non-uniform buildup of plating material.
- Process is limited to the physical capabilities of the vendor base (such as, the plating tank size).
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage).
- Process requires good part drainage characteristics.

ALTERNATIVE/S:

- Prefinished materials
- Special coatings
- Paint
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impact of the alternative would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.2.6 PLATE—COPPER/NICKEL/CHROME (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Copper/nickel/chrome plating is the preferred finish when aesthetics are required.
2. Copper/nickel/chrome (electrolytic) plating is not recommended for parts that have numerous recessed areas (pockets), blind holes, or closed hems. See Figure 2–3.
3. Copper/nickel/chrome plating is not recommended for surfaces that require painting.
4. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–3.

REASON/S:

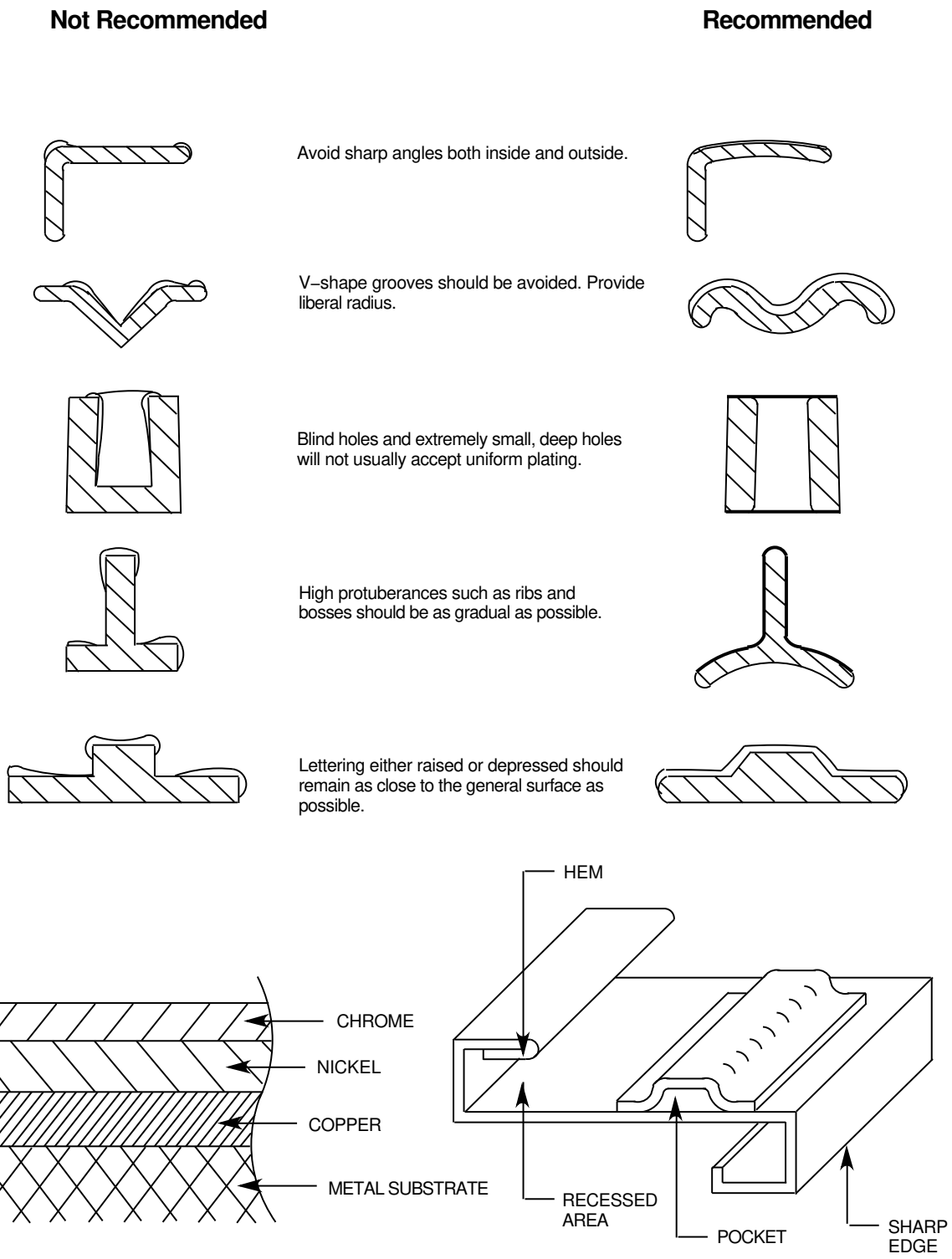
- Irregular surface conditions, closed hems, blind holes, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–3.
- Chrome has poor paint adhesion capabilities.
- Process requires good part drainage characteristics.

ALTERNATIVE/S:

- Prefinished materials
- Special coatings
- Paint
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–3: Plate—Copper/Nickel/Chrome (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.
CHROME
NICKEL
COPPER
METAL SUBSTRATE
HEM
RECESSED AREA
POCKET
SHARP EDGE

2.2.7 SPECIAL COATINGS

INFORMATION

RULE: Features within the special coating process will be divided into the following categories.

- Silk screening
- Vacuum deposition (not recommended)

  NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S: There are other more cost-effective methods of coating (finishing) sheet metal.

These feature categories should support most engineering requirements for finishing (special coatings) sheet metal and will support future AI tool development, for example, The Design Advisor.

ALTERNATIVE/S:

- Prefinished materials
- Paint
- Other base materials, such as stainless steel
- Plating

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.2.8 SPECIAL COATINGS—SILK SCREENING

GUIDELINE

RULE/S:

1. Silk Screening is an effective means of applying lettering and graphics. See Figure 2–4.
2. Silk screening is effective for multicolored applications.
3. Silk screening is effective on raised or multiple surfaces. See Figure 2–4.

REASON/S:

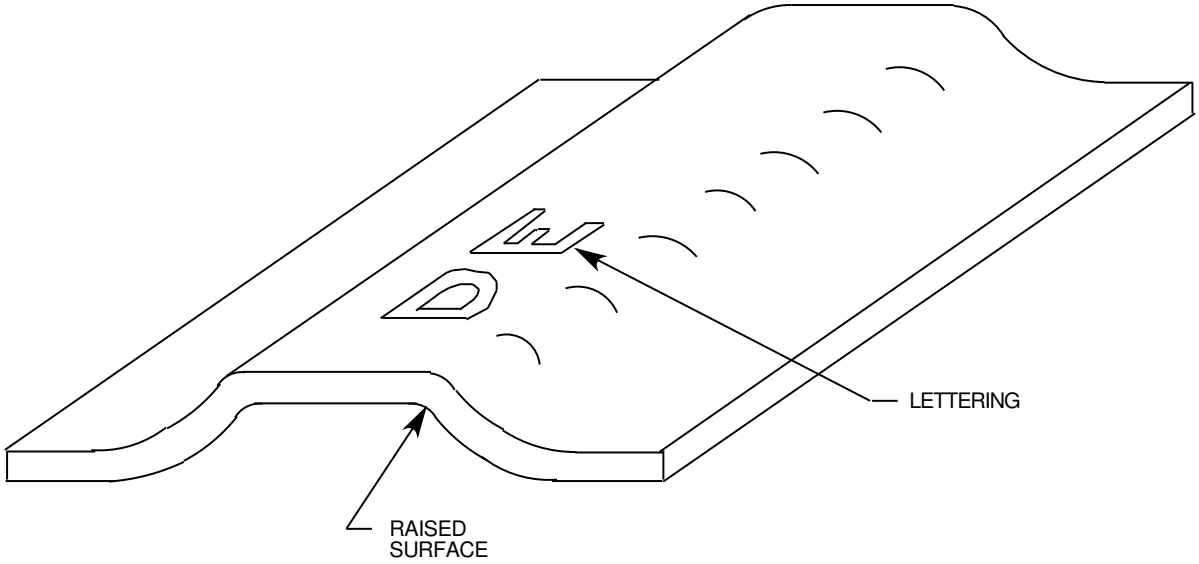
- The Silk screening process has good registration and fine detailing capabilities.
- Silk screening has masking capabilities built into the process.

ALTERNATIVE/S:

- Labels
- Laser marking
- Stamp/pad printing
- Mask and paint

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–4: Special Coatings—Silk Screening



2.2.9 TEXTURING

INFORMATION

RULE/S:

1. Texturing can best be achieved by applying a smooth coat of paint followed by a textured coat of paint over a smooth metal substrate. See Figure 2–5.
2. Texturing can be achieved by applying a smooth coat of paint over a pretextured metal substrate (not recommended).
3. Texturing can be achieved by plating over a pretextured metal substrate. (Not recommended)

REASON/S:

- Painting of sheet metal is a standard manufacturing process readily available over a large vendor base.
- Pretextured sheet metal is subject to limited process capabilities and vendor base.
- Pretextured metals may not match plating or paint-applied textures. See a Producibility Engineer and DEC STD 092-0 for specific design recommendations.

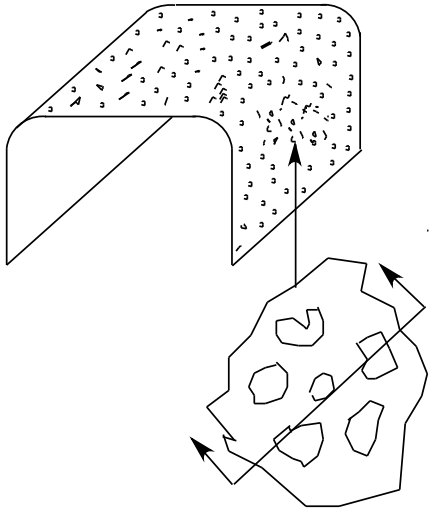
ALTERNATIVE:

None

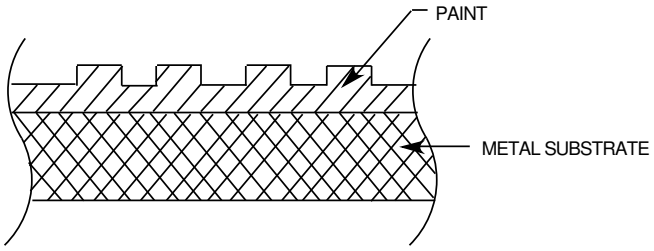
ALTERNATIVE IMPACT:

Not applicable

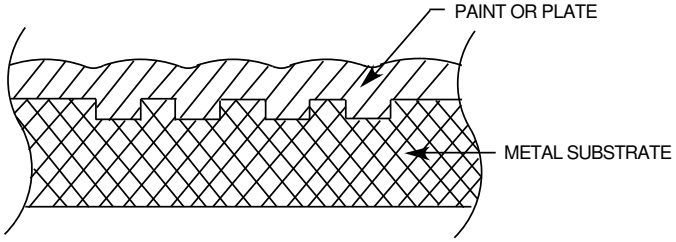
Figure 2–5: Texturing



A. Recommended



B. Not Recommended



2.3 FINISHING—SHIELDING

2.3.1 PLATE/PAINT/SPECIAL COATINGS

INFORMATION

RULE/S:

1. Plating is a finishing option when sufficient shielding characteristics are *not* available in base material.
2. Paint is not recommended for shielding applications.
3. Special coatings is not recommended for shielding applications.

   NOTE: Shielding effectiveness is the result of many design aspects (such as, component configurations, part geometry, coating thickness, and so on).

   Refer to DEC STD 092-0 for more specific information.

REASON/S:

- Plating of sheet metal is an acceptable standard manufacturing process readily available over a large vendor base.
- Painting and special coatings are presently nonapplicable in enhancing shielding capabilities of low carbon steel.
- Special coatings, such as vacuum deposition, are not recommended because there are more cost-effective methods of finishing sheet metal.
- Paints are not available with the electrical conductive properties that are needed for shielding applications.

ALTERNATIVE/S:

- Other base materials, such as stainless steel
- Prefinished materials

ALTERNATIVE IMPACT: Positive or negative impacts of the alternative would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.3.2 PLATE

INFORMATION

RULE: Features within the plating process will be divided into the following categories. The order of recommended use is:

- Zinc with yellow chromate
- Zinc with blue bright chromate
- Nickel (electrolytic)
- Nickel (electroless)
- Tin
- Tin-lead

Chrome (not recommended)
Gold (not recommended)
Silver (not recommended)
Copper (not recommended)

NOTE: Refer to DEC STD EL-00092-00 for more specific information.

REASON/S:

- The relative ranking is based upon cost versus conductivity characteristics, technical expertise, and availability (approved vendor base).
- Chrome is not recommended since it is a poor conductor of electricity.
- Gold and silver are not recommended since there are more cost-effective methods of finishing sheet metal.
- Copper is not recommended because it has poor corrosion resistance.
- These feature categories should support all engineering requirements for finishing (shielding) low carbon sheet metal, and will support future AI tool development, for example, The Design Advisor.

ALTERNATIVE/S:

- Prefinished materials
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impacts of the alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.3.3 PLATE—ELECTROLYTIC

INFORMATION

RULE/S:

1. Electrolytic plating is a finishing process with the following characteristics:
   - May require a copper undercoat for adhesion.
   - Preferred for thick coating applications.
   - Has bright finish capabilities.
   - May have poor paint adhesion capabilities.
   - Has size constraints (such as, large parts may be difficult to plate) .
   - Generally less susceptible to surface discoloration (such as, finger prints) than electroless plating.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage.

   NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- Process produces a non-uniform build up of plating material.
- Process is limited to the physical capabilities of the vendor base (such as, the plating tank size).
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage).
- Process requires good part drainage characteristics.

ALTERNATIVE/S:

- Prefinished materials
- Other plating, such as electroless
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impacts of the alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.3.4 PLATE—ZINC WITH YELLOW CHROMATE (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. This finish is preferred when minimal electrical surface conductivity is required.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to rocessing problems, such as poor drainage. See Figure 2–6.

REASON/S:

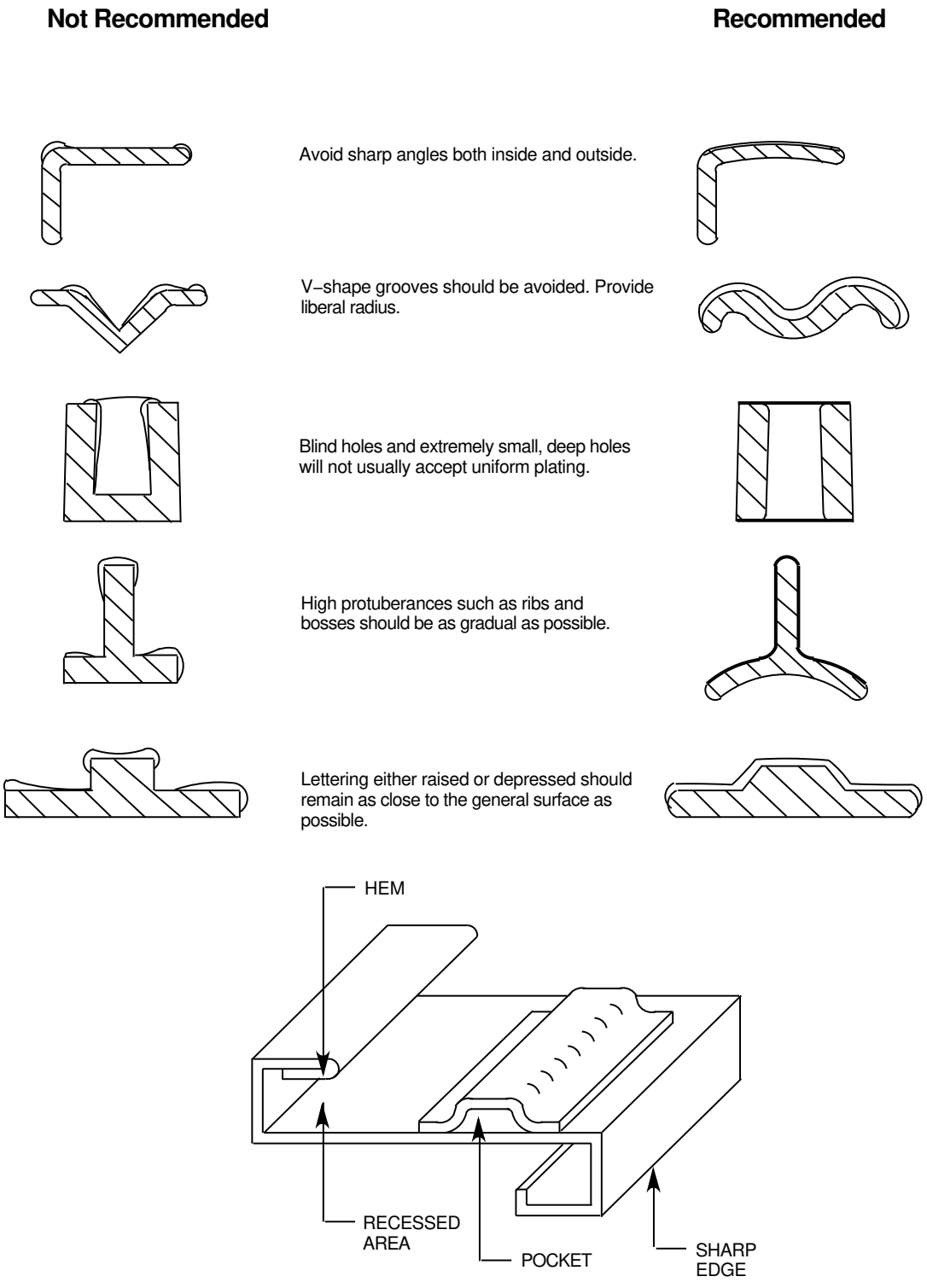
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–6.
- Process requires good part drainage characteristics.
- Zinc with yellow chromate is the most economical for meeting DEC STD 092-0 for corrosion resistance.

ALTERNATIVE/S:

- Other plating, such as zinc with blue bright chromate
- Other base materials, such as stainless steel
- Prefinished materials

ALTERNATIVE IMPACT: Positive or negative impacts of the alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–6: Plate—Zinc with Yellow Chromate (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.
HEM
RECESSED AREA
POCKET
SHARP EDGE

2.3.5 PLATE—ZINC WITH BLUE BRIGHT CHROMATE (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. This finish is preferred rather than zinc with yellow chromate only when better electrical surface conductivity is required.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–7.

   NOTE: Zinc with blue bright chromate offers lower corrosion resistance than zinc with yellow chromate.

   Zinc with blue bright chromate may incur additional process and assembly costs.

REASON/S:

- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–7.
- Process requires good part drainage characteristics.

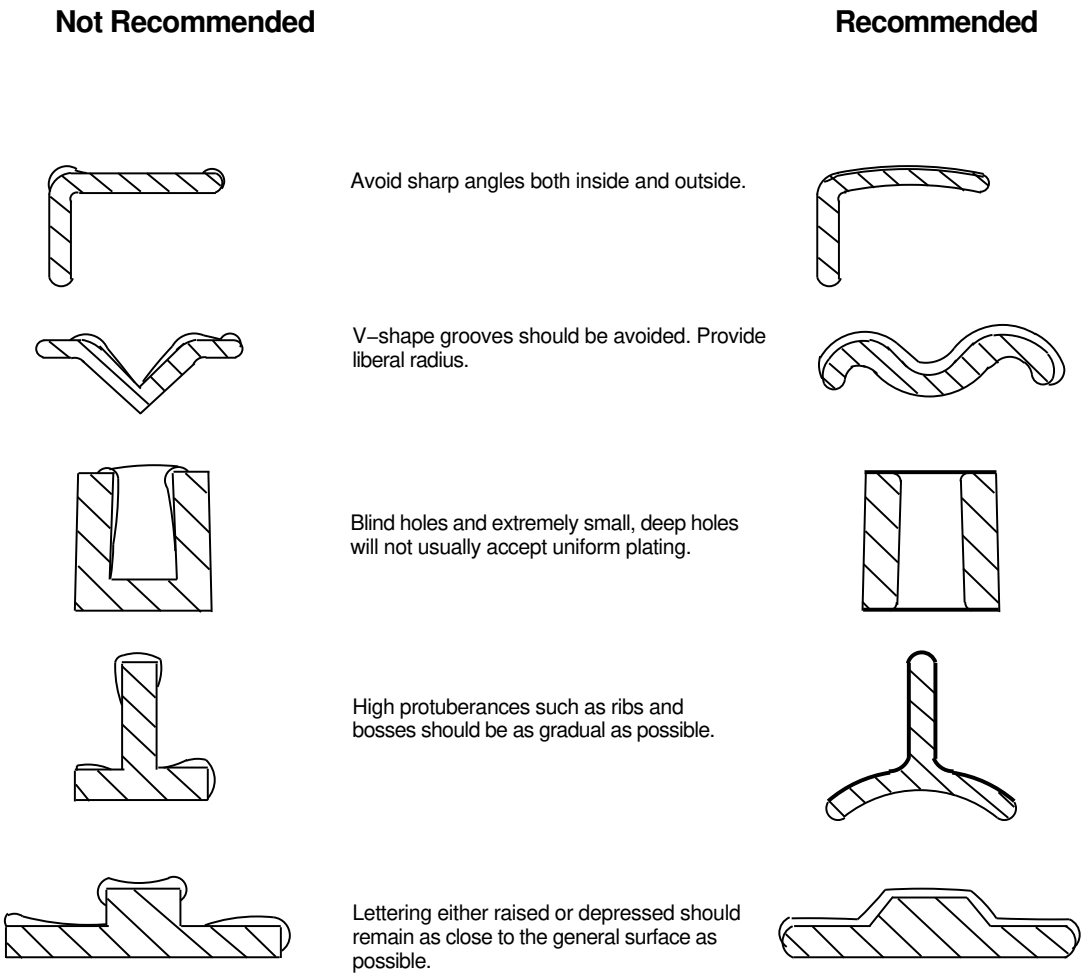
  NOTE: Refer to DEC STD 092-0 for more detailed information with respect to surface conductivity.

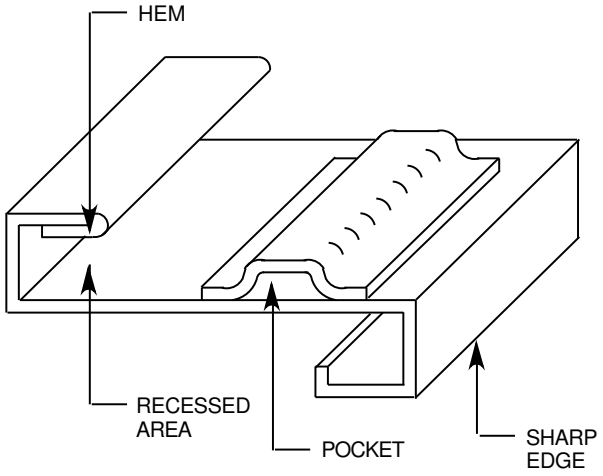
ALTERNATIVE/S:

- Other plating, such as zinc with yellow chromate
- Other base materials, such as stainless steel
- Prefinished materials

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–7: Plate—Zinc with Blue Bright Chromate (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.



2.3.6 PLATE—NICKEL (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Nickel plating is recommended for shielding applications when aesthetics and wearability are required.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–8.

REASON/S:

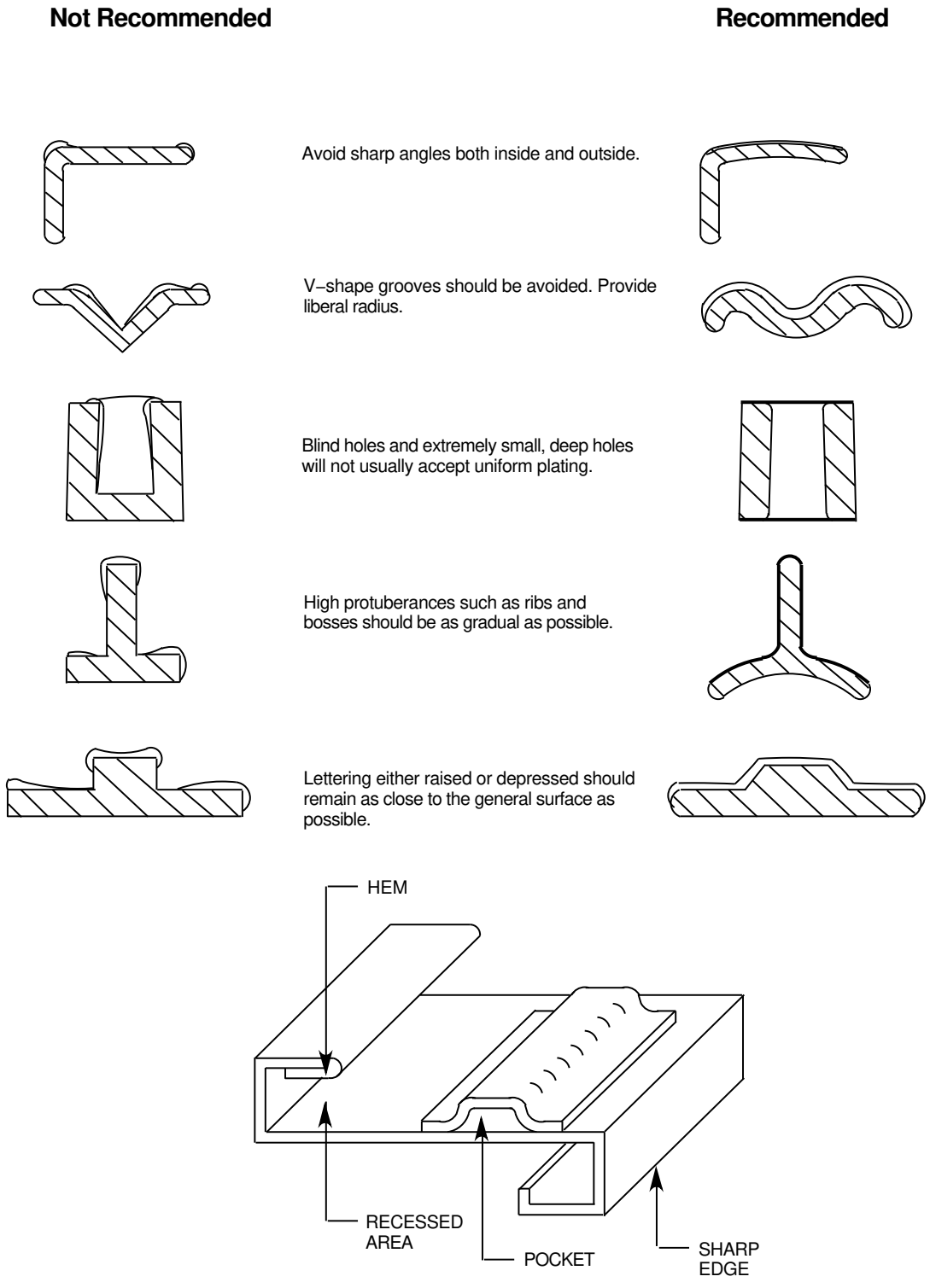
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–8.
- Process requires good part drainage characteristics.
- Nickel is harder than tin or zinc.

ALTERNATIVE/S:

- Other plating, such as electroless nickel
- Other base materials, such as stainless steel
- Prefinished materials

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–8: Plate—Nickel (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.
HEM
RECESSED AREA
POCKET
SHARP EDGE

2.3.7 PLATE—TIN (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Tin plating is recommended for shielding applications when solderability and/or low electrical contact resistance is required, as long as wearability is not a requirement.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–9.

REASON/S:

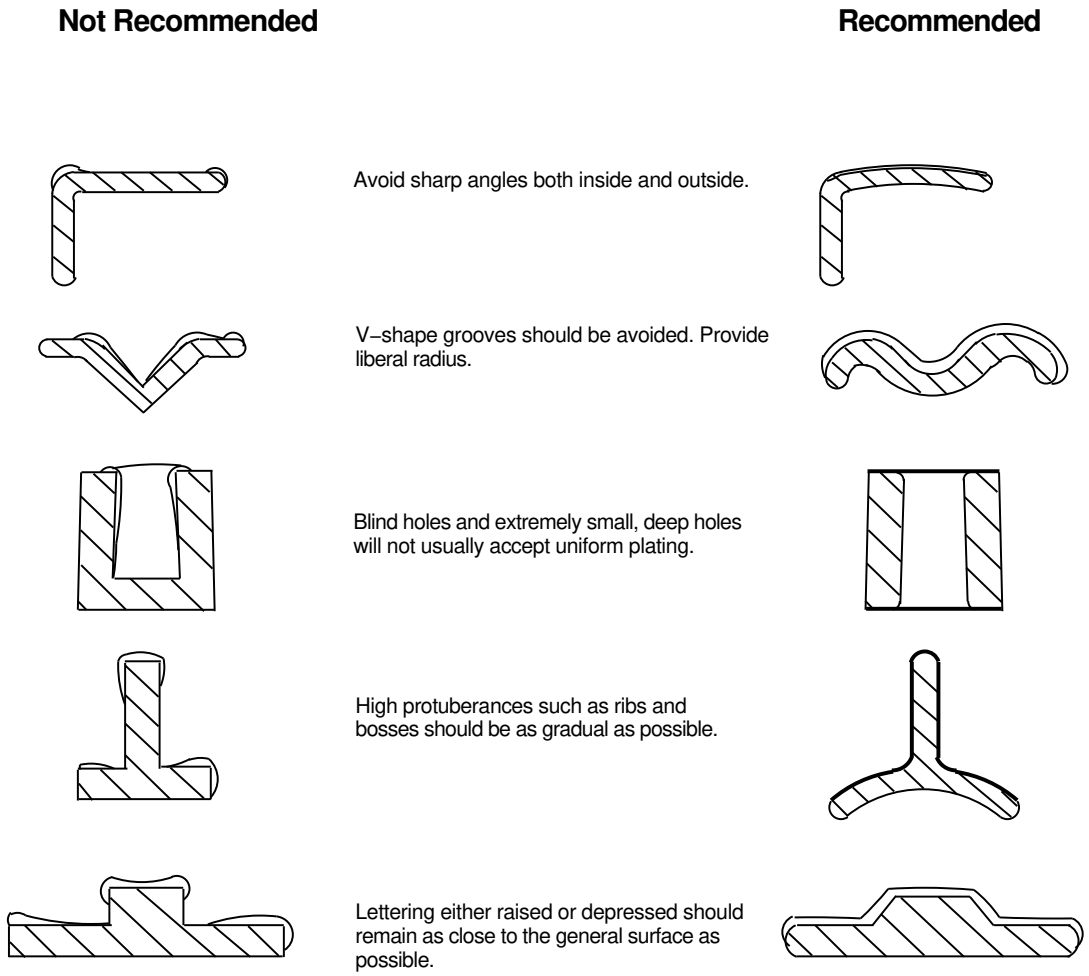
- Tin has good soldering capabilities.
- Tin has high electrical surface conductivity.
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–9.
- Process requires good part drainage characteristics.

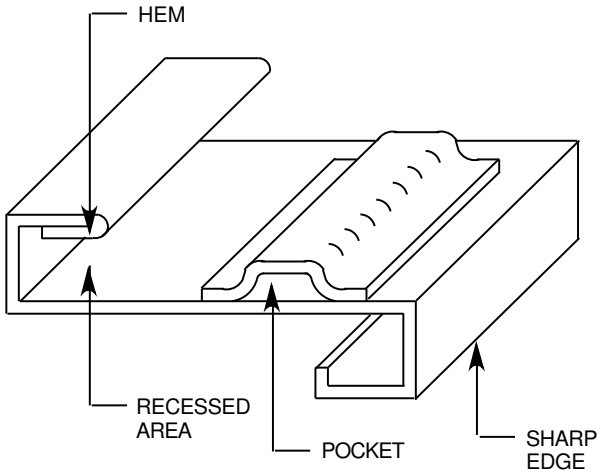
ALTERNATIVE/S:

- Other plating, such as tin-lead
- Prefinished materials
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–9: Plate—Tin (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.



2.3.8 PLATE—TIN-LEAD (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Tin-lead plating is recommended for shielding applications when solderability and/or low electrical contact resistance is required, as long as wearability is not a requirement.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–10.

REASON/S:

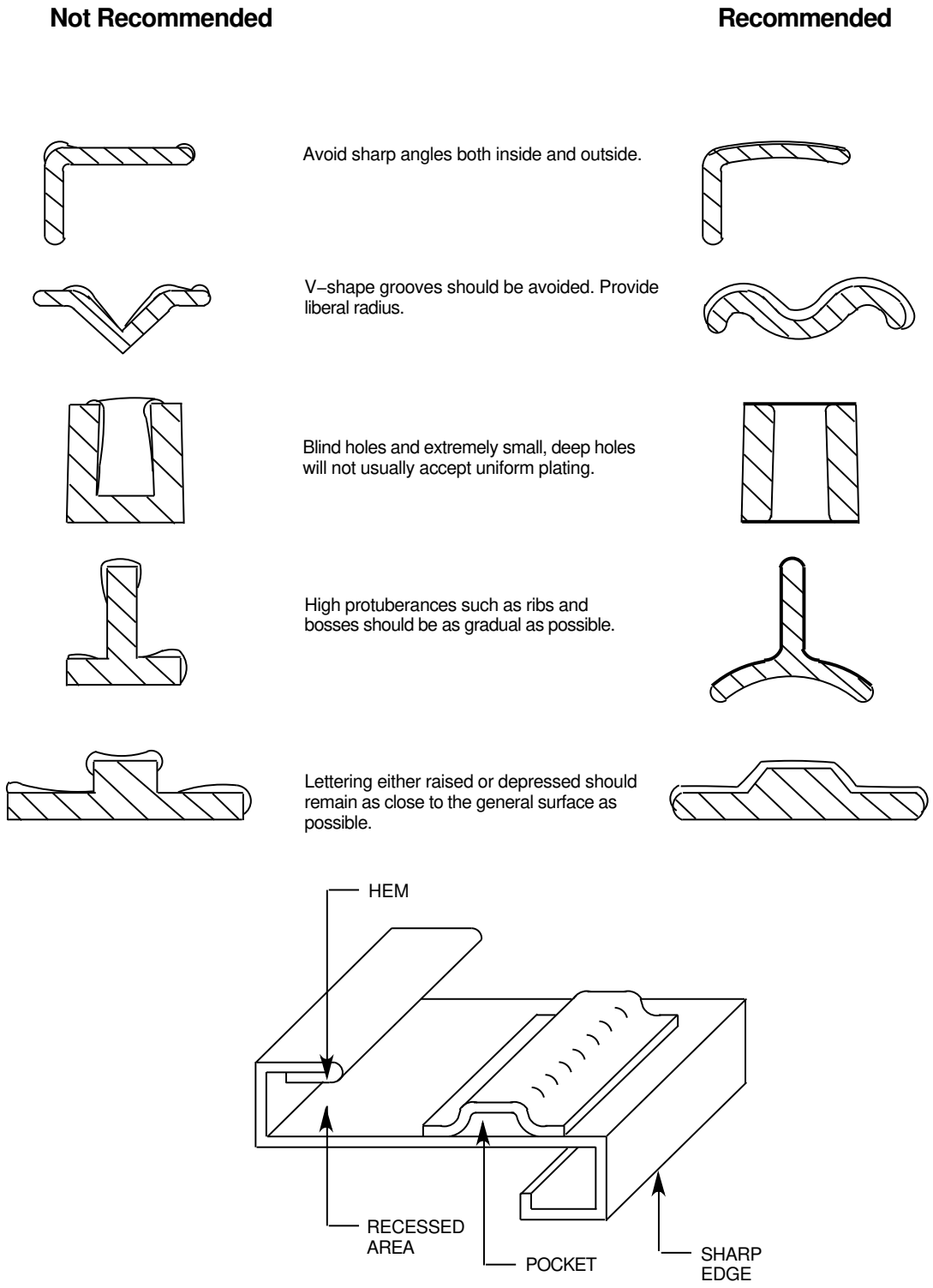
- Tin-lead has good soldering capabilities.
- Tin-lead has high electrical surface conductivity.
- Tin-lead is susceptible to fretting corrosion.
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–10.
- Process requires good part drainage characteristics.

ALTERNATIVE/S:

- Other plating, such as tin
- Prefinished materials
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–10: Plate—Tin-Lead (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.
HEM
RECESSED AREA
POCKET
SHARP EDGE

2.3.9 PLATE—ELECTROLESS

INFORMATION

RULE/S:

1. Electroless plating is a finishing process with the following characteristics:
   - A more costly process than electrolytic in most applications.
   - May have poor paint adhesion capabilities.
   - In normal applications, the plated finish is dictated by the base material surface condition.
   - Process is preferred for parts with complex geometry.
   - Process has size constraints (for instance, large parts may be difficult to plate).
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems (such as, poor drainage areas).

   NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- Electroless is a submersion plating process.
- Process requires good part drainage characteristics.
- Electroless follows the contour of the substrate surface (nonleveling).
- The process is limited to the physical capabilities of the vendor base (such as, the plating tank size).
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage).
- This process does not require electric current for deposition, resulting in a uniform coating.

ALTERNATIVE/S:

- Other platings, such as electrolytic
- Other base materials, such as stainless steel
- Prefinished materials

ALTERNATIVE IMPACT: Positive or negative impact of the alternative would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.3.10 PLATE—NICKEL (ELECTROLESS)

GUIDELINE

RULE/S:

1. Electroless nickel plating is recommended for shielding applications when wearability and/or solderability are required.
2. This process is preferred for parts with complex geometry.
3. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems (such as, poor drainage areas). See Figure 2–11.

   NOTE: Different alloys of electroless nickel can provide for different performance requirements.

REASON/S:

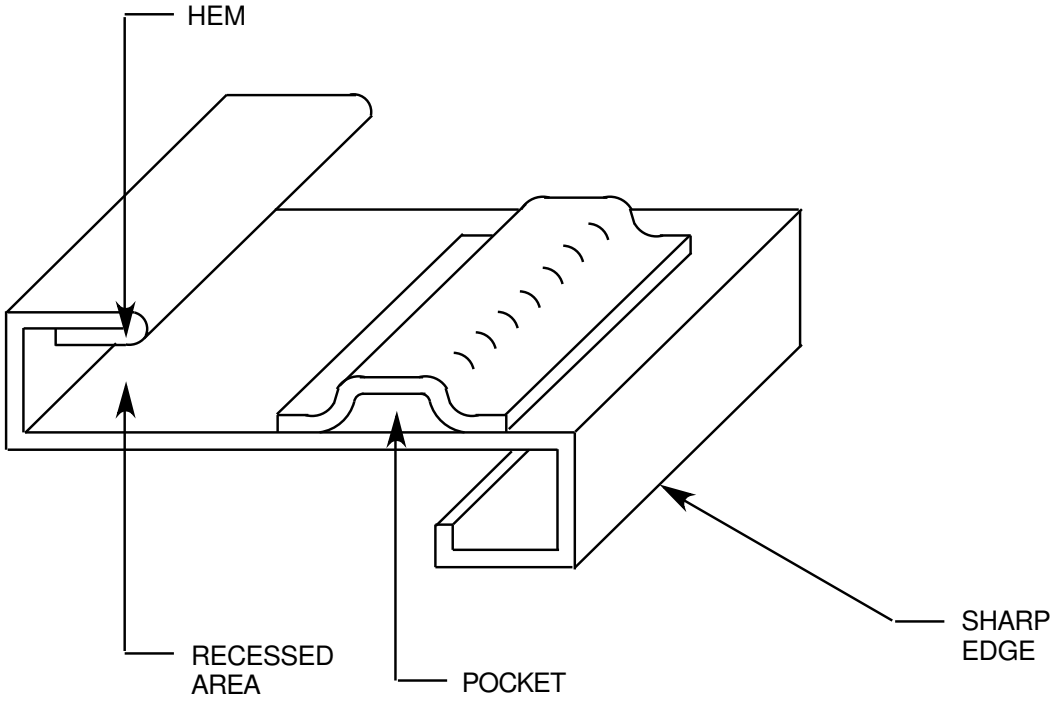
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–11.
- Process requires good part drainage characteristics.
- Electroless nickel has soldering capabilities (better than zinc).
- Electroless nickel is harder than tin or zinc because of the phosphorous content.
- This process does not require an electric current for deposition, resulting in a uniform coating.

ALTERNATIVE/S:

- Other plating, such as electrolytic nickel
- Other base materials, such as stainless steel
- Prefinished materials

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–11: Plate—Nickel (Poor Drainage)



2.4 FINISHING—CORROSION PROTECTION

2.4.1 PAINT/PLATE/SPECIAL COATINGS

INFORMATION

RULE/S:

1. Plating is a finishing option when the following criteria must be met:
   - Sufficient corrosive protective characteristics are *not* available in base material
   - Most cost-effective on applications needing conductive surfaces
2. Painting is a finishing option when the following criteria must be met:
   - Sufficient corrosive protective characteristics are *not* available in base material
   - Most cost-effective on cosmetic applications
3. Special coatings is a finishing option when the following criteria must be met:
   - Sufficient corrosive protective characteristics are *not* available in base material
   - Accommodates special design requirements

REASON/S:

- Plating and painting are acceptable standard manufacturing processes readily available over a large vendor base.
- Special coatings are developed to satisfy special surface conditions that cannot be satisfied through the use of standard painting and/or plating materials.

ALTERNATIVE/S:

- Prefinished materials
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impacts of the alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.4.2 PLATE

INFORMATION

RULE/S: Features within the plating process will be divided into the following categories. The order of recommended use is:

- Zinc with yellow chromate
- Zinc with blue bright chromate
- Nickel (electrolytic)
- Nickel (electroless)
- Tin
- Tin-lead

Chrome (not recommended)
Gold (not recommended)
Silver (not recommended)
Copper (not recommended)

NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- The relative ranking is based upon cost versus corrosion/protection characteristics, technical expertise and availability (approved vendor base).
- These feature categories should support all engineering requirements for finishing (corrosion/protection) of low carbon steel sheet metal, and will support future AI tool development, for example, The Design Advisor.
- Chrome, gold, and silver are not recommended since there are more cost-effective methods of finishing sheet metal.
- Copper and silver are not recommended because they are susceptible to tarnish.

ALTERNATIVE/S:

- Paint
- Special coatings
- Prefinished materials
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.4.3 PLATE—ELECTROLYTIC

INFORMATION

RULE/S:

1. Electrolytic plating is a finishing process with the following characteristics:
   - May require a copper undercoat for adhesion
   - Preferred for thick coating applications
   - Has bright finish capabilities
   - May have poor paint adhesion capabilities
   - Has size constraints (such as, large parts may be difficult to plate)
   - Generally less susceptible to surface discoloration (such as, fingerprints) than electroless plating
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage.

   NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- Process produces a non-uniform buildup of plating material.
- Process is limited to the physical capabilities of the vendor base (such as, the plating tank size).
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage).
- Process requires good part drainage characteristics.

ALTERNATIVE/S:

- Prefinished materials
- Special coatings
- Paint
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impact of the alternative would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.4.4 PLATE—ZINC WITH YELLOW CHROMATE (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–12.
2. Zinc with yellow chromate is the preferred finish when only corrosion protection is required.
3. Zinc offers galvanic protection to steel.

   NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

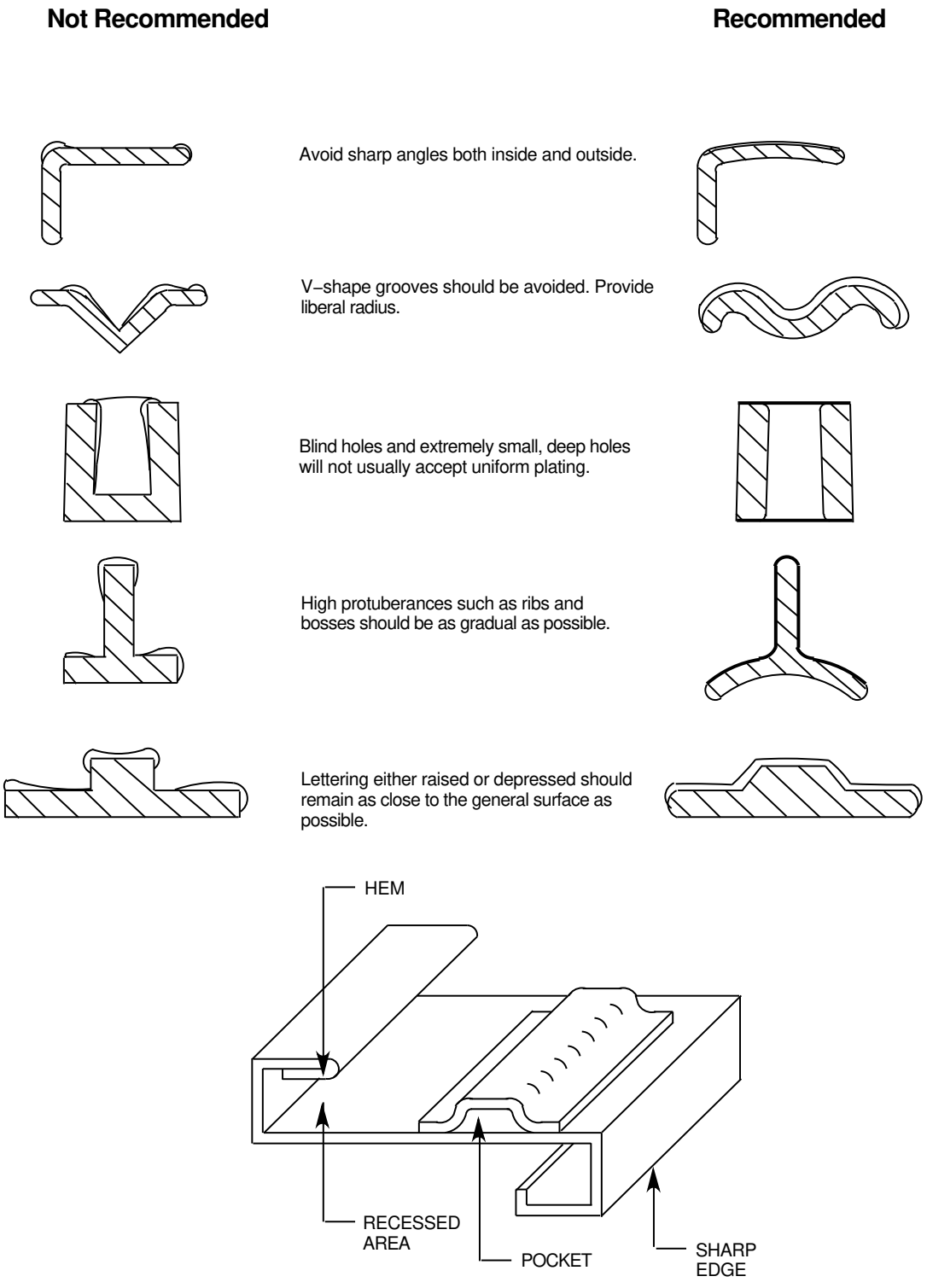
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–12.
- Process requires good part drainage characteristics.
- Zinc with yellow chromate is the most economical for meeting DEC STD 092-0 for corrosion resistance.

ALTERNATIVE/S:

- Other base materials, such as stainless steel
- Prefinished materials
- Other platings, such as zinc with blue bright chromate
- Paint
- Special coatings

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–12: Plate—Zinc with Yellow Chromate (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.
HEM
RECESSED AREA
POCKET
SHARP EDGE

2.4.5 PLATE—ZINC WITH BLUE BRIGHT CHROMATE (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. This finish is preferred rather than zinc with yellow chromate only when better electrical surface conductivity is required.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–13.
3. Zinc offers galvanic protection to steel.

   NOTE: Zinc with blue bright chromate offers lower corrosion resistance that zinc with yellow chromate.

   Zinc with blue bright chromate may incur additional process and/or assembly costs.

REASON/S:

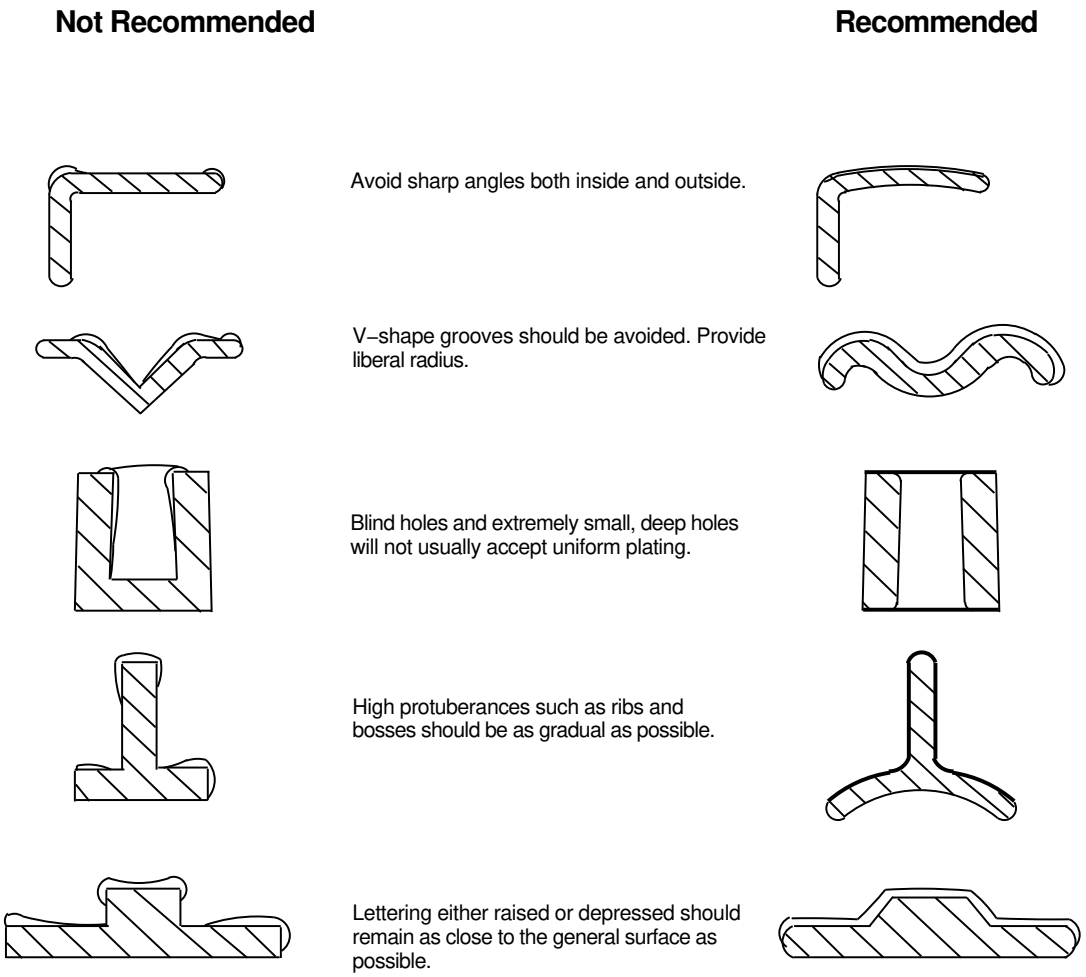
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–13.
- Process required good part drainage characteristics.

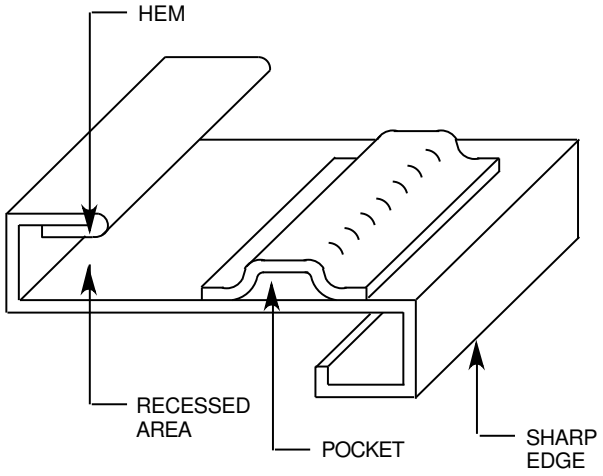
ALTERNATIVE/S:

- Other plating, such as zinc with yellow chromate
- Other base materials, such as stainless steel
- Prefinished materials
- Paint
- Special coatings

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–13: Plate—Zinc with Blue Bright Chromate (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.



2.4.6 PLATE—NICKEL (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–14.
2. Nickel plating is recommended for shielding applications when aesthetics and wearability are required.

REASON/S:

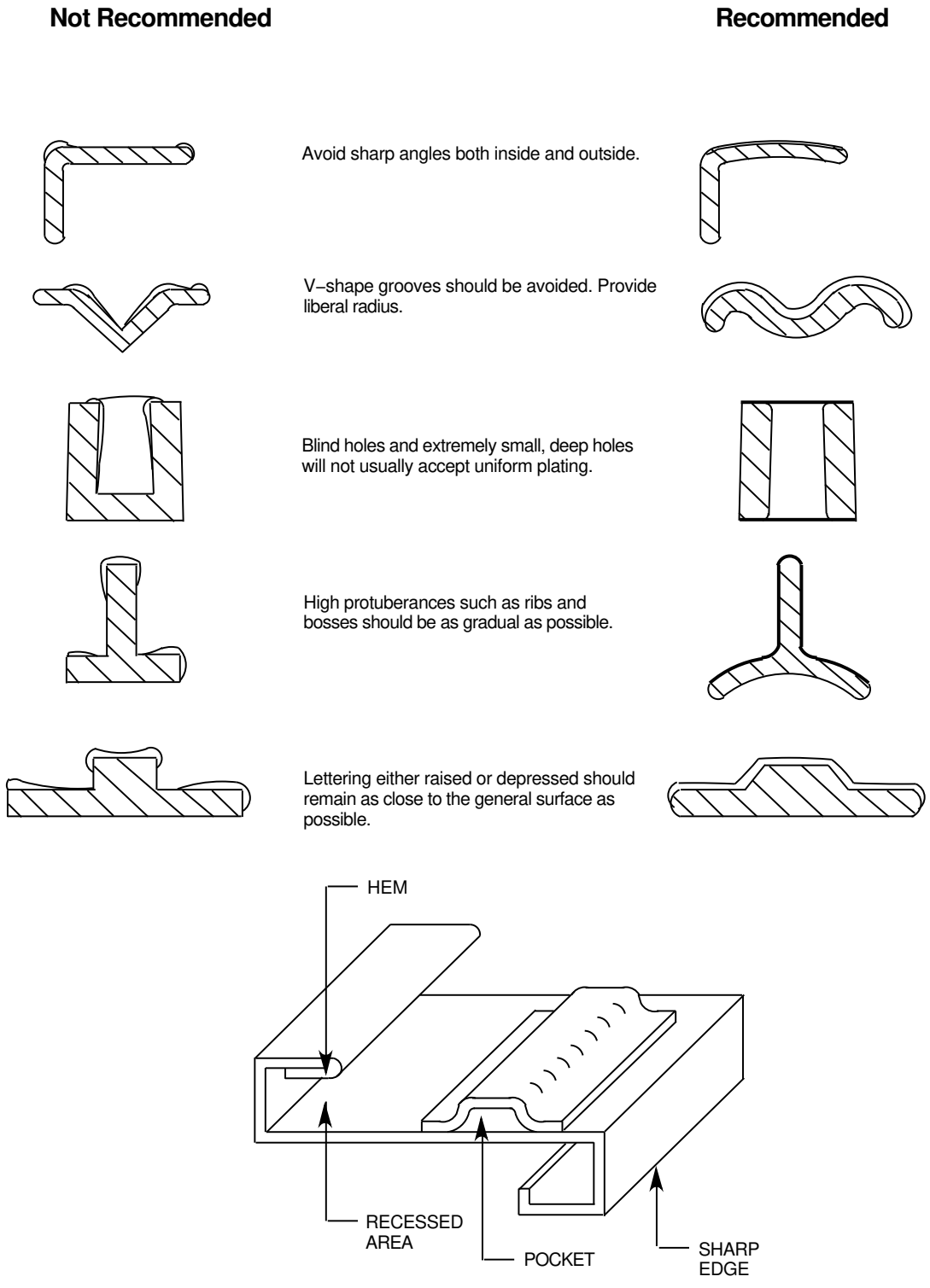
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–14.
- Process requires good part drainage characteristics.
- Nickel is harder than tin or zinc.

ALTERNATIVE/S:

- Other plating, such as electroless nickel
- Other base materials, such as stainless steel
- Prefinished materials
- Paint
- Special coatings

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–14: Plate—Nickel (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.
HEM
RECESSED AREA
POCKET
SHARP EDGE

2.4.7 PLATE—TIN (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Tin plating is recommended for corrosion protection applications when solderability and/or low electrical contact resistance is required, as long as wearability is not a requirement.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–15.

REASON/S:

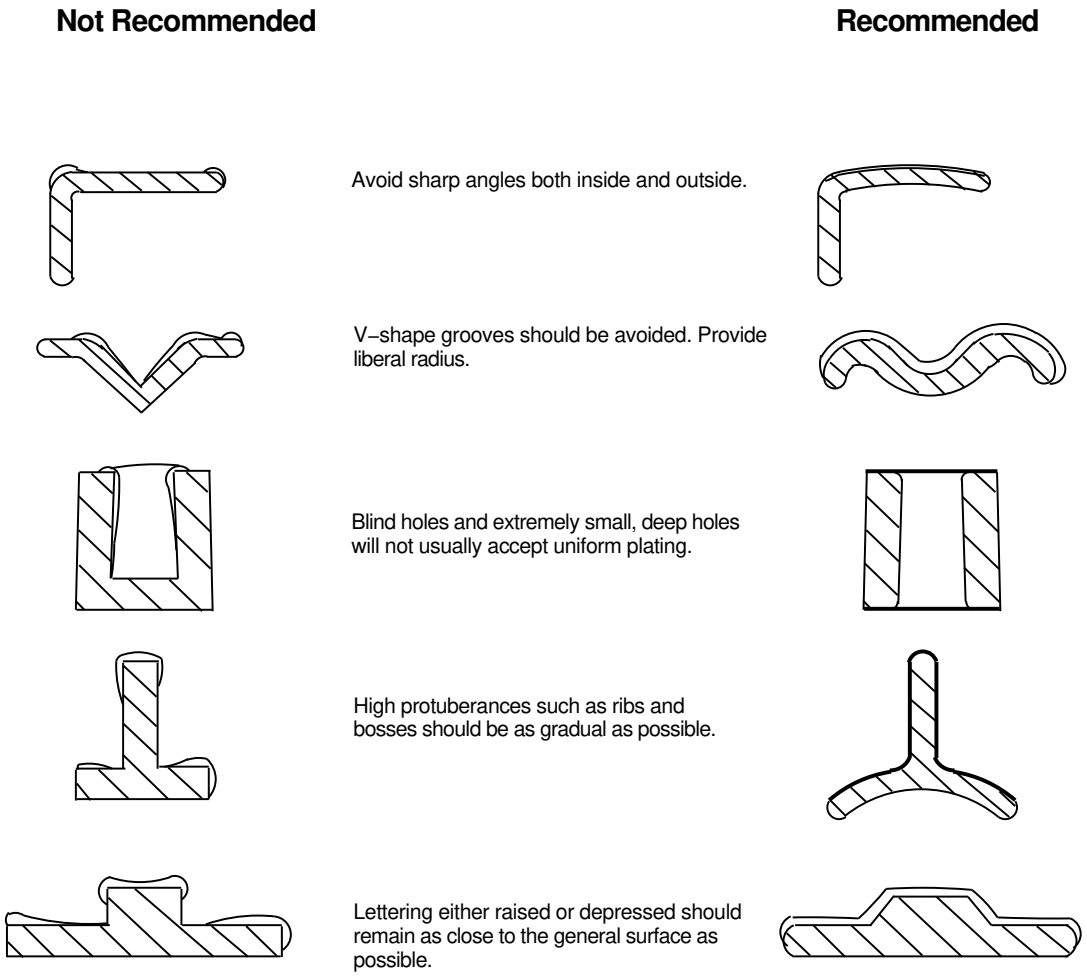
- Tin has good soldering capabilities.
- Tin has high electrical surface conductivity.
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–15.

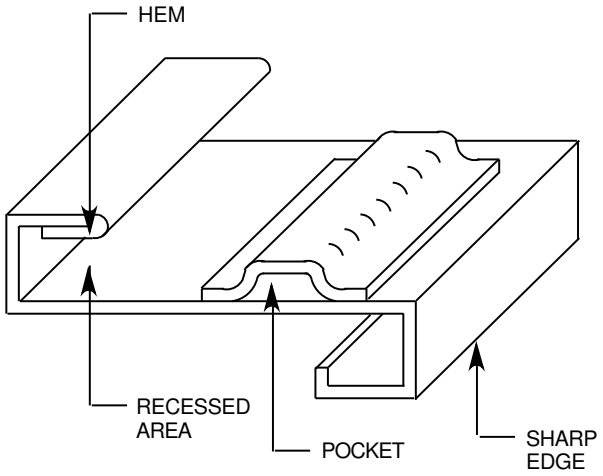
ALTERNATIVE/S:

- Other plating, such as tin-lead
- Prefinished materials
- Other base materials, such as stainless steel
- Paint
- Special coatings

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–15: Plate—Tin (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.



2.4.8 PLATE—TIN-LEAD (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Tin-lead plating is recommended for corrosion protection applications when solderability and/or low electrical contact resistance is required.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–16.

REASON/S:

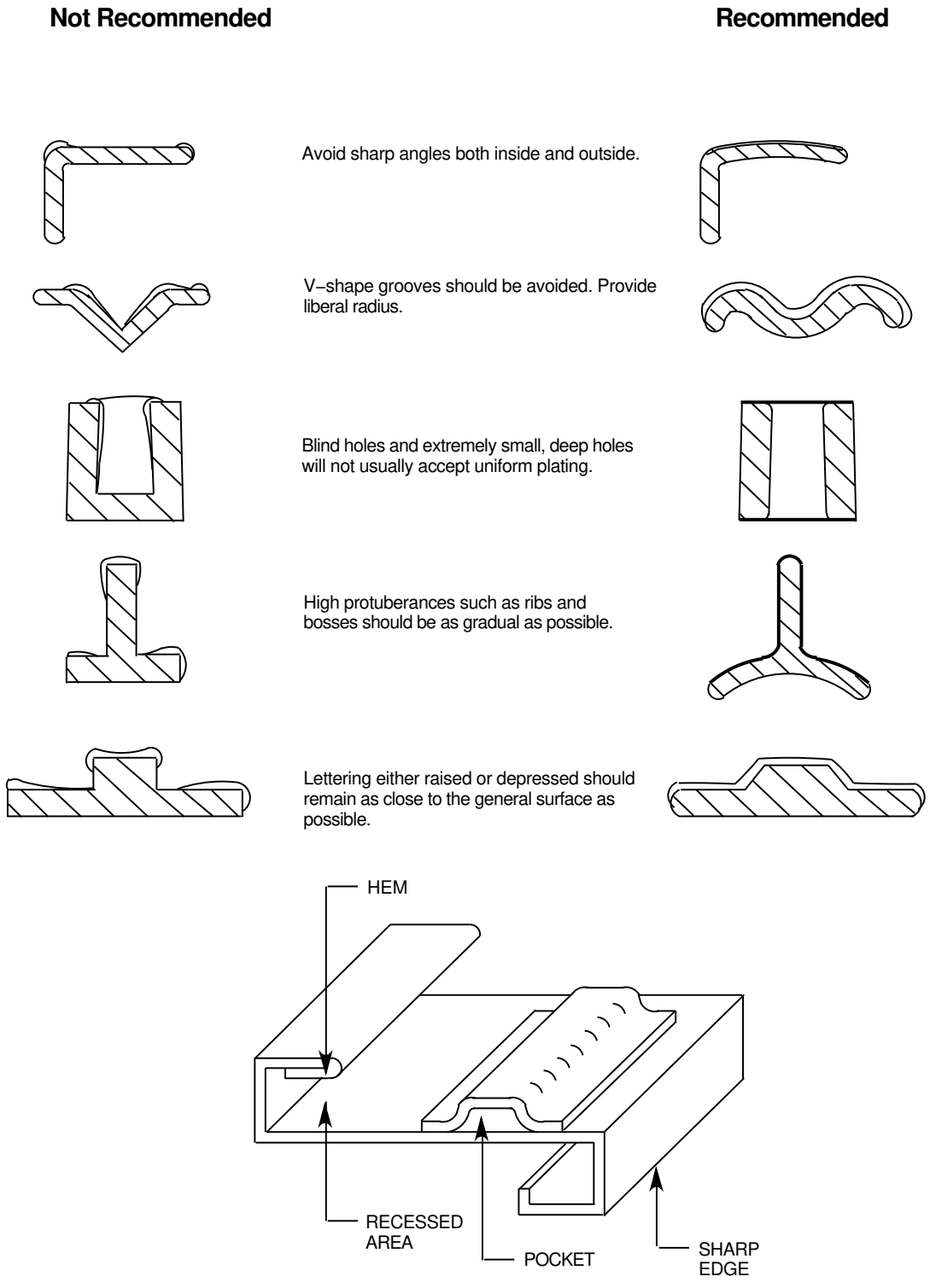
- Tin-lead has good soldering capabilities.
- Tin-lead has high electrical surface conductivity.
- Tin-lead is susceptible to fretting corrosion.
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–16.

ALTERNATIVE/S:

- Other plating, such as tin
- Prefinished materials
- Other base materials, such as stainless steel
- Paint
- Special coatings

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–16: Plate—Tin-Lead (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.
HEM
RECESSED AREA
POCKET
SHARP EDGE

2.4.9 PLATE—ELECTROLESS

INFORMATION

RULE/S:

Electroless plating is a finishing process with the following characteristics:

- A more costly process than electrolytic in most applications.
- May have poor paint adhesion capabilities.
- In normal applications, the plated finish is dictated by the base material surface condition.
- This process is preferred for parts with complex geometry.
- Process has size constraints (such as, large parts may be difficult to plate).

NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- Electroless is a submersion plating process.
- Process requires good part drainage characteristics.
- Electroless follows the contour of the substrate surface (nonleveling).
- Process is limited to the physical capabilities of the vendor base (such as, the plating tank size).
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage).
- This process does not require electric current for deposition, resulting in a uniform coating.

ALTERNATIVE/S:

- Other platings, such as electrolytic
- Other base materials, such as stainless steel
- Prefinished materials

ALTERNATIVE IMPACT: Positive or negative impact of the alternative would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.4.10 PLATE—NICKEL (ELECTROLESS)

GUIDELINE

RULE/S:

1. Nickel plating is recommended for corrsion protection application when wearability and solderability are required
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage). See Figure 2–17.

   NOTE: Different alloys of electroless nickel can provide for different performance requirements.
3. This process is preferred for parts with complex geometry.

REASON/S:

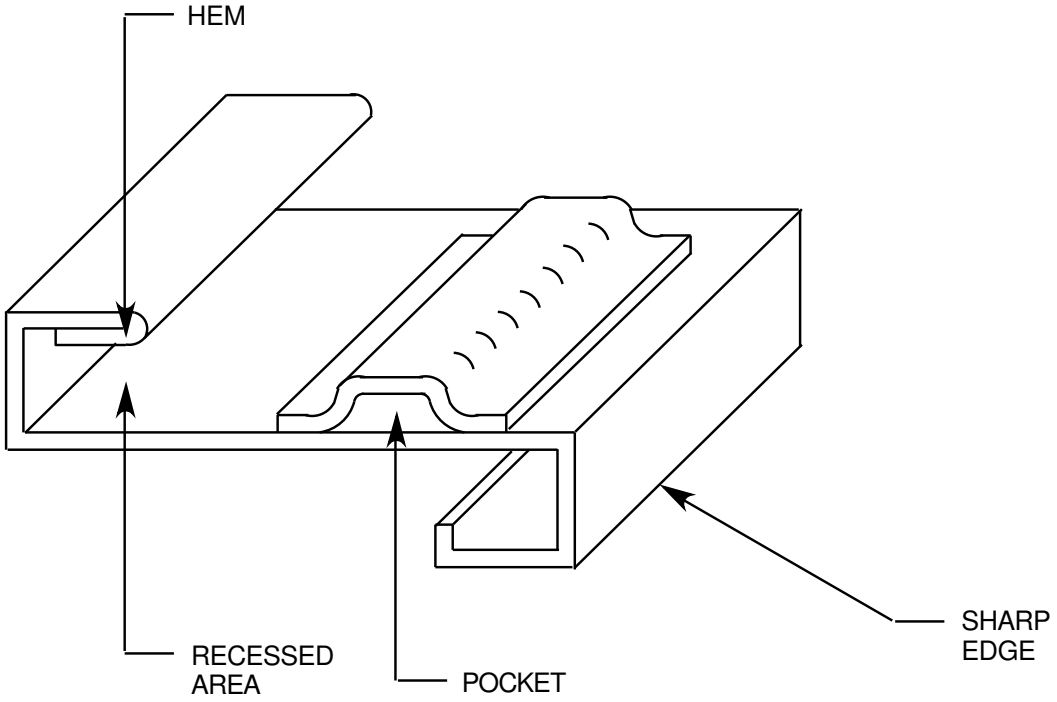
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–17.
- Process requires good part drainage characteristics.
- Electroless nickel has soldering capabilities that are better than zinc
- Electroless nickel is harder than tin or zinc because of the phosphorous content
- This process does not require electric current for deposition, resulting in a uniform coating.

ALTERNATIVE/S:

- Other plating, such as electrolytic nickel
- Other base materials, such as stainless steel
- Paints
- Special coatings

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–17: Plate—Nickel (Electroless)



2.4.11 PAINT

INFORMATION

RULE/S:

Features within the paint process will be divided into the following categories. The order of recommended use is:

- Enamel
- Lacquer
- Powder coat

NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- The relative ranking is based upon cost, technical expertise, and available/approved vendor base.
- These feature categories should support most engineering requirements for finishing (painting) sheet metal, and will support future AI tool development, for instance, The Design Advisor.

ALTERNATIVE/S:

- Plating
- Special coatings
- Prefinished materials
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT:

Not applicable

2.4.12 PAINT—ENAMEL/LACQUER

GUIDELINE

RULE:

1. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–18.
2. Primer coat(s) may be required to satisfy proper coverage and/or adhesion. See a Producibility Engineer for specific design recommendations.
3. Lacquers are generally used for prototype development and not volume manufacturing.
4. Enamels are recommended for most corrosion protection applications.

REASON/S:

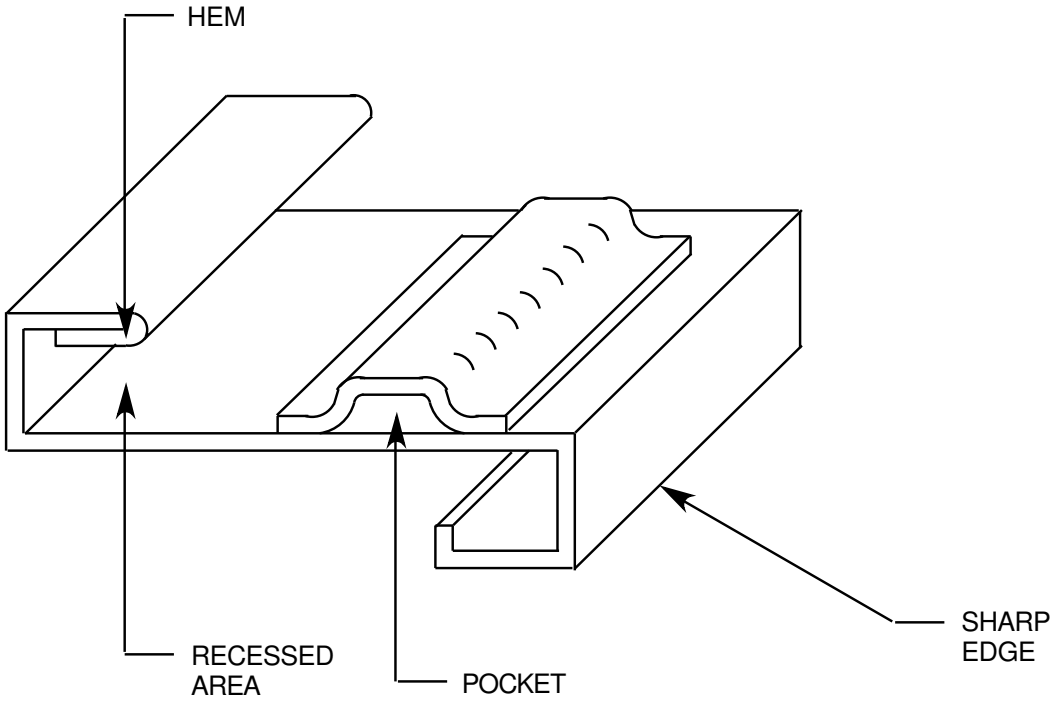
- Enamels and lacquers are applied using a spraying process (not submersion) in most applications.
- Pretreatment process may require good part drainage characteristics.
- Enamels and lacquers have good coverage capabilities.
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–18.

ALTERNATIVE/S:

- Prefinished materials
- Special coatings
- Plating
- Other paints, such as powder coats
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impact of alternatives, would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–18: Paint—Enamel/Lacquer (Corrosion Protection)



2.4.13 PAINT—POWDER COAT

GUIDELINE

RULE/S:

1. Powder coat is recommended for corrosion protection applications when wearability, chemical resistance, and/or additional corrosion protection is required.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–19.

REASON/S:

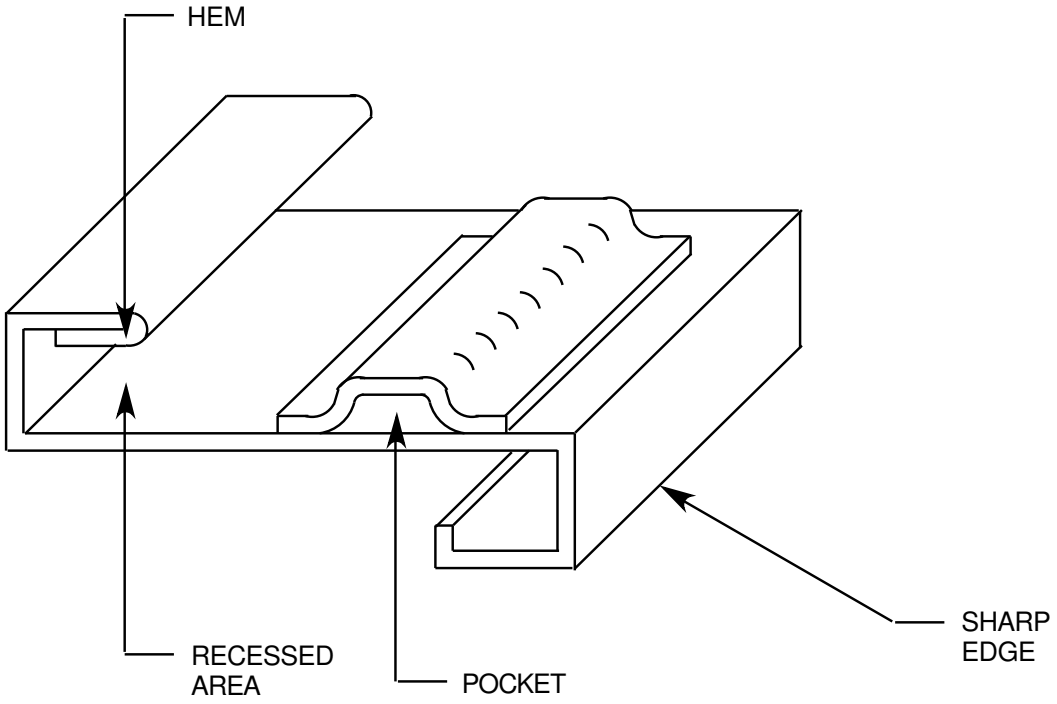
- Powder coat process permits heavier coatings to be applied.
- Pretreatment process may require good part drainage characteristics.
- Powder coat process has a limited approved vendor base.
- Texturing (per DEC STD 092-0) cannot be achieved by means of the powder coat processes.
- Abrasion, chemical, and corrosion resistance are inherent in the powder coating.
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–19.

ALTERNATIVE/S:

- Other paints, such as enamels or lacquers
- Prefinished materials
- Other base materials, such as stainless steel
- Platings
- Special coatings

ALTERNATIVE IMPACT: Positive or negative impact of the alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–19: Paint—Powder Coat



2.4.14 SPECIAL COATINGS

INFORMATION

RULE:

Special coatings are developed to satisfy special surface conditions that cannot be satisfied through the use of standard painting and/or plating materials.

REASON/S:

- There are other more cost-effective methods of coating (finishing) sheet metal.
- These feature categories should support most engineering requirements for finishing (special coatings) sheet metal and will support future AI tool development, for example, The Design Advisor.

ALTERNATIVE/S:

- Prefinished materials
- Painting
- Plating
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.5 FINISHING—WEARABILITY

2.5.1 PAINT/PLATE/SPECIAL COATINGS

INFORMATION

RULE/S:

1. Plating is a finishing option when the following criteria must be met:
   - Acceptable abrasion resistance is *not* available in base material.
   - Special (increased or decreased) friction requirements.
2. Special coatings are developed to satisfy special surface conditions that cannot be satisfied through the use of standard painting and plating materials.
3. Paint is a finishing option when the following criteria must be met:
   - Acceptable abrasion resistance is *not* available in base material.
   - Special (increased or decreased) friction requirements.

   NOTE: There are other methods of increasing wearability of low carbon steel See a Producibility Engineer for specific design recommendations.

   A hard coat is an acceptable means of protecting silk-screened surfaces.

   Refer to DEC STD 092-0 for more specific information.

REASON/S:

- Plating materials, such as chrome, are available which offer improved wearability protection than those inherent to the base materials.
- Coatings have been developed to satisfy special abrasion and/or frictional requirements. See a Producibility Engineer for specific design requirements.

ALTERNATIVE/S:

- Other base materials, such as stainless steel
- Prefinished materials
- Other processes, such as heat treating

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives, would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.5.2 PAINT

INFORMATION

RULE: Features within the paint process will be divided into the following categories.

- Enamel (not recommended)
- Lacquer (not recommended)
- Powder coat

  NOTE: Refer to *DEC STD 092-0 Finish and Color Standard—Introduction and General Requirements* for more specific information.

REASON/S:

- These feature categories should support most engineering requirements for finishing (painting) sheet metal and will support future AI tool development, for example, The Design Advisor.
- Enamels and lacquers are not recommended due to poor abrasion resistance.

ALTERNATIVE/S:

- Prefinished materials
- Plating
- Special coatings
- Other base materials, such as stainless steel
- Other processes, such as heat treating

ALTERNATIVE IMPACT:

Not applicable

2.5.3 PAINT—POWDER COAT

GUIDELINE

RULE/S:

1. Powder coat is recommended for wearability applications when corrosion protection and chemical resistance are required.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–20.

REASON/S:

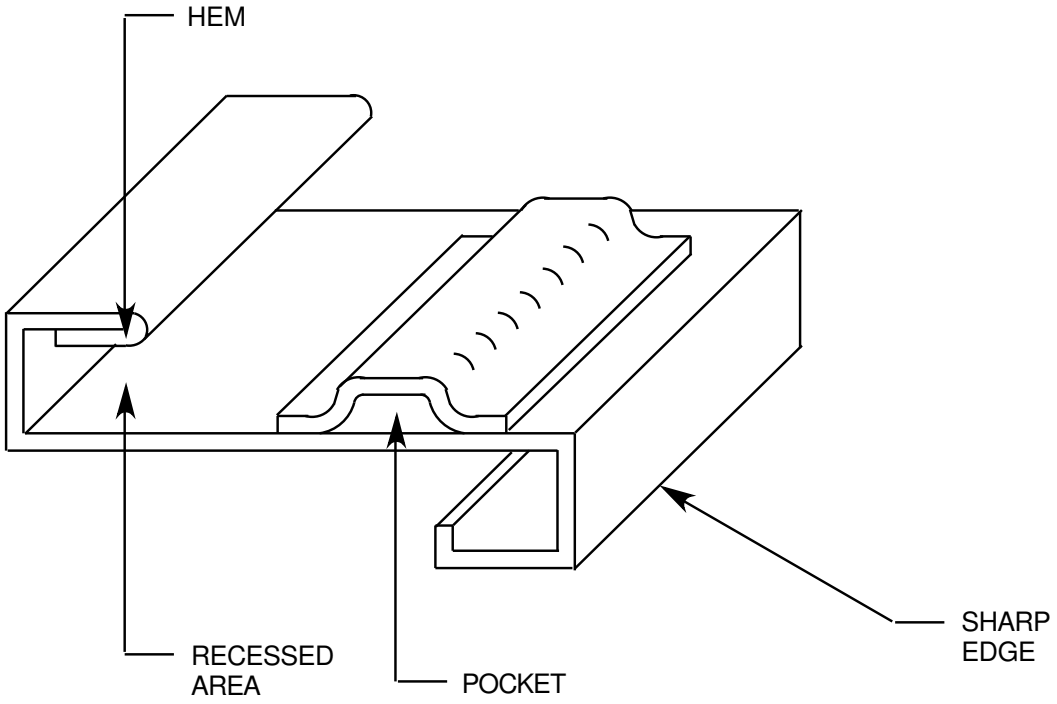
- Powder coat process permits heavier coatings to be applied.
- Pretreatment process may require good part drainage characteristics.
- Powder coat process has a limited approved vendor base.
- Texturing (per DEC STD 092-0) cannot be achieved by means of the powder coat processes.
- Abrasion, chemical, and corrosion resistance are inherent in the powder coating.
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–20.

ALTERNATIVE/S:

- Prefinished materials
- Other base materials, such as stainless steel
- Platings
- Special coatings
- Other processes, such as heat treating

ALTERNATIVE IMPACT: Positive or negative impact of the alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–20: Wearability Paint—Powder Coat



2.5.4 PLATE

INFORMATION

RULE:

Features within the plating process will be divided into the following categories. The order of recommended use is:

- Nickel alloys
- Nickel
- Chrome
- Zinc (not recommended)
- Gold (not recommended)
- Tin (not recommended)
- Tin-lead (not recommended)
- Silver (not recommended)
- Copper (not recommended)

NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- The relative ranking is based upon technical expertise and availability approved vendor base.
- Zinc, gold, tin, tin-lead, silver, and copper are not recommended for wearability applications because of poor abrasion resistance.
- There are more cost-effective methods of finishing sheet metal than using gold and silver.
- These feature categories should support most engineering requirements for finishing (wearability) of sheet metal, and will support future AI tool development, for example, The Design Advisor.

ALTERNATIVE/S:

- Prefinished materials
- Special coatings
- Other base materials, such as stainless steel
- Other processes, such as heat treating
- Paint

ALTERNATIVE IMPACT: Positive or negative impact of the alternative would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.5.5 ELECTROLESS

INFORMATION

RULE/S:

1. Electroless plating is a finishing process with the following characteristics:
   - A more costly process than electrolytic in most applications.
   - May have poor paint adhesion capabilities.
   - In normal applications, the plated finish is dictated by the base material surface condition.
   - Process is preferred for parts with complex geometry.
   - Has size constraints (such as, large parts may be difficult to plate).
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage.

   NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- Electroless is a submersion plating process.
- Process requires good part drainage characteristics.
- Electroless follows the contour of the substrate surface (nonleveling).
- The process is limited to the physical capabilities of the vendor base (such as, the plating tank size).
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage).
- This process does not require electric current for deposition, resulting in a uniform coating.

ALTERNATIVE/S:

- Other base materials, such as stainless steel
- Prefinished materials
- Other platings, such as electrolytic
- Special coatings
- Paint
- Other processes, such as heat treating

ALTERNATIVE IMPACT: Positive or negative impact of the alternative would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.5.6 PLATE—NICKEL ALLOYS (ELECTROLESS)

GUIDELINE

RULE/S:

1. Electroless nickel alloy platings are the preferred finish when wearability is required.
2. This process is preferred for parts with complex geometry.
3. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–21.

REASON/S:

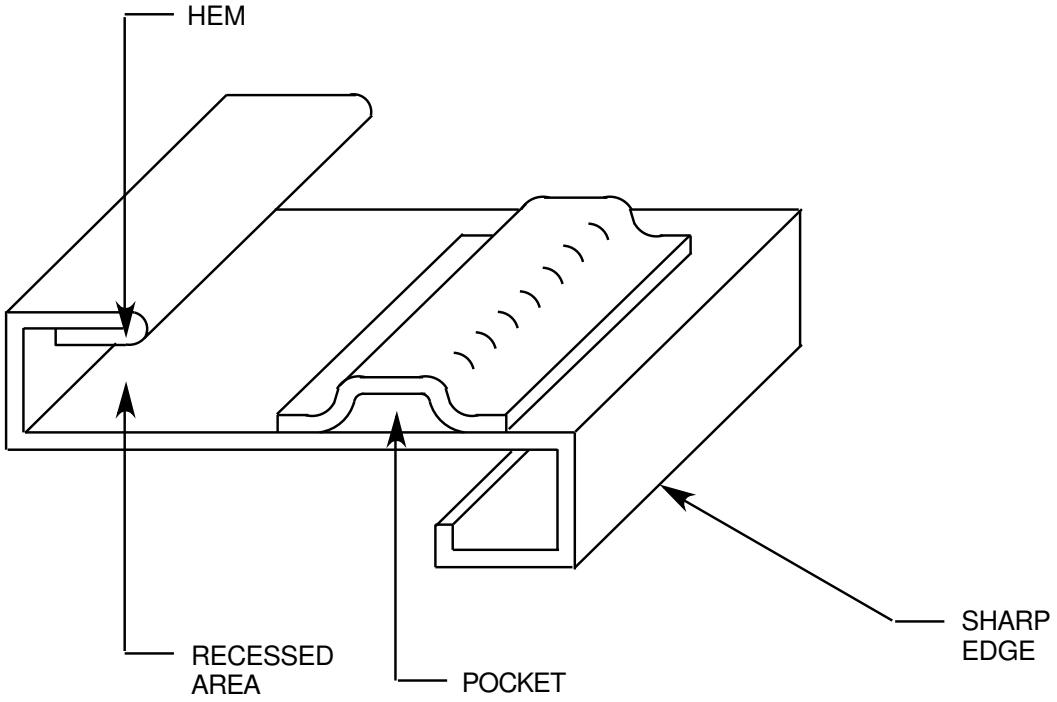
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–21.
- Process requires good part drainage characteristics.
- Electroless nickel alloys are harder than electrolytic nickel plating.

ALTERNATIVE/S:

- Other plating, such as chrome
- Special coatings
- Other processes, such as, heat treating
- Prefinished materials
- Other base materials, such as stainless steel
- Paint

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–21: Plate—Nickel Alloys (Electroless)



2.5.7 PLATE—ELECTROLYTIC

INFORMATION

RULE/S:

1. Electrolytic plating is a finishing process with the following characteristics:
   - May require a copper undercoat for adhesion
   - Preferred for thick coating applications
   - Has bright finish capabilities
   - May have poor paint adhesion capabilities
   - Has size constraints (such as, large parts may be difficult to plate)
   - Generally less susceptible to surface discoloration (such as, fingerprints) than electroless plating
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage.

REASON/S:

- Process produces a non-uniform buildup of plating material.
- Process requires good part drainage characteristics.
- Process is limited to the physical capabilities of the vendor base (such as, the plating tank size).
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesions or non-uniform coating (thickness and coverage).

ALTERNATIVE/S:

- Prefinished materials
- Special coatings
- Paint
- Other base materials, such as stainless steel
- Other plating, such as electroless
- Other processes, such as heat treating

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

2.5.8 PLATE—CHROME (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Chrome plating is recommended for wearability applications when aesthetics are required.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–22.

REASON/S:

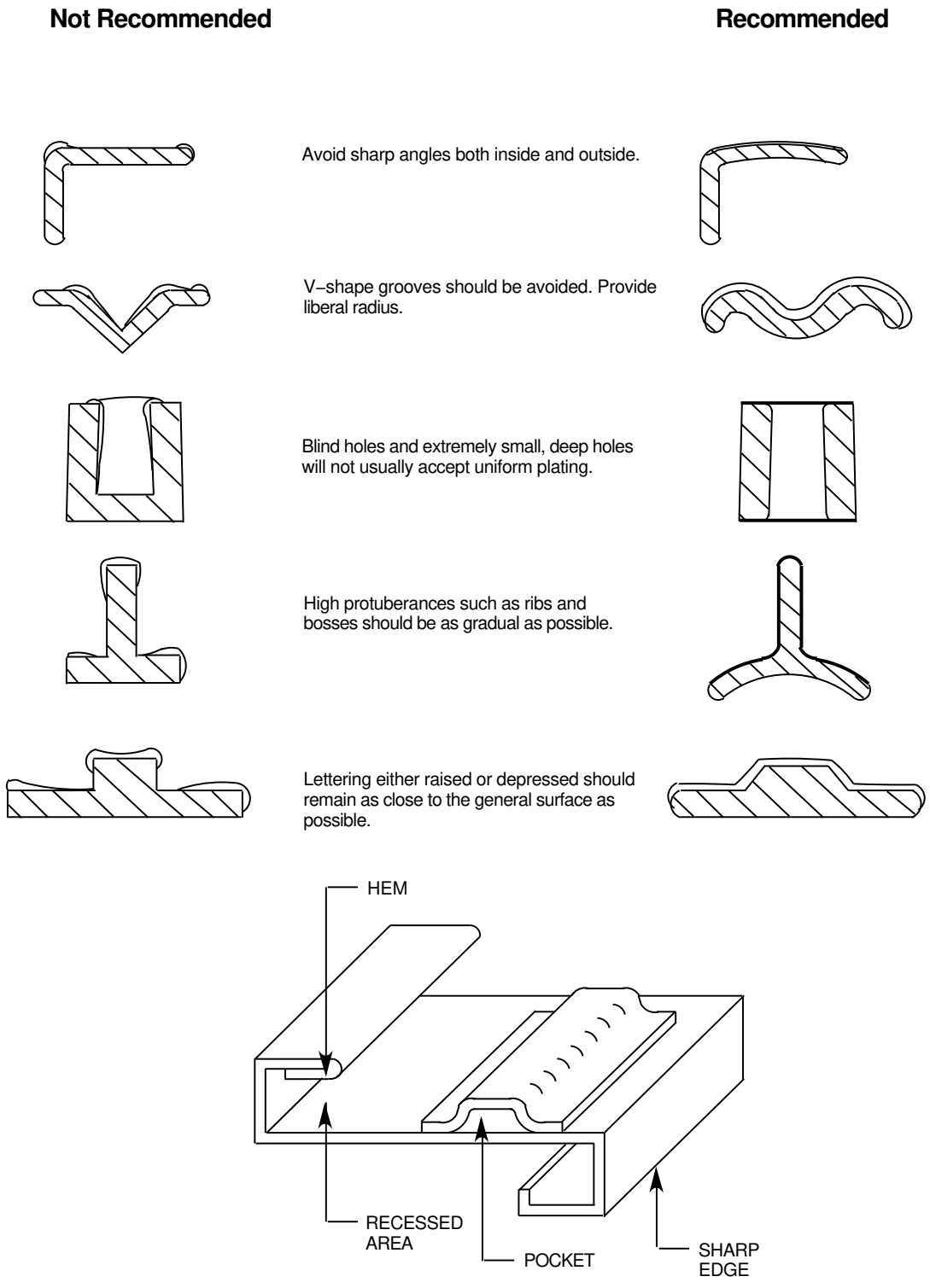
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–22.
- Process requires good part drainage characteristics.
- Chrome has good tarnish resistance.

ALTERNATIVE/S:

- Other plating, such as electroless nickel
- Prefinished materials
- Special Coatings
- Other base materials, such as stainless steel
- Other processes, such as heat treating
- Paint

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. Refer to Producibility Engineer.

Figure 2–22: Plate—Chrome (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.
HEM
RECESSED AREA
POCKET
SHARP EDGE

2.5.9 PLATE—NICKEL (ELECTROLYTIC)

GUIDELINE

RULE/S:

1. Electrolytic nickel plating is recommended for wearability applications when high electrical surface conductivity is required.
2. Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can lead to processing problems, such as poor drainage. See Figure 2–23.

REASON/S:

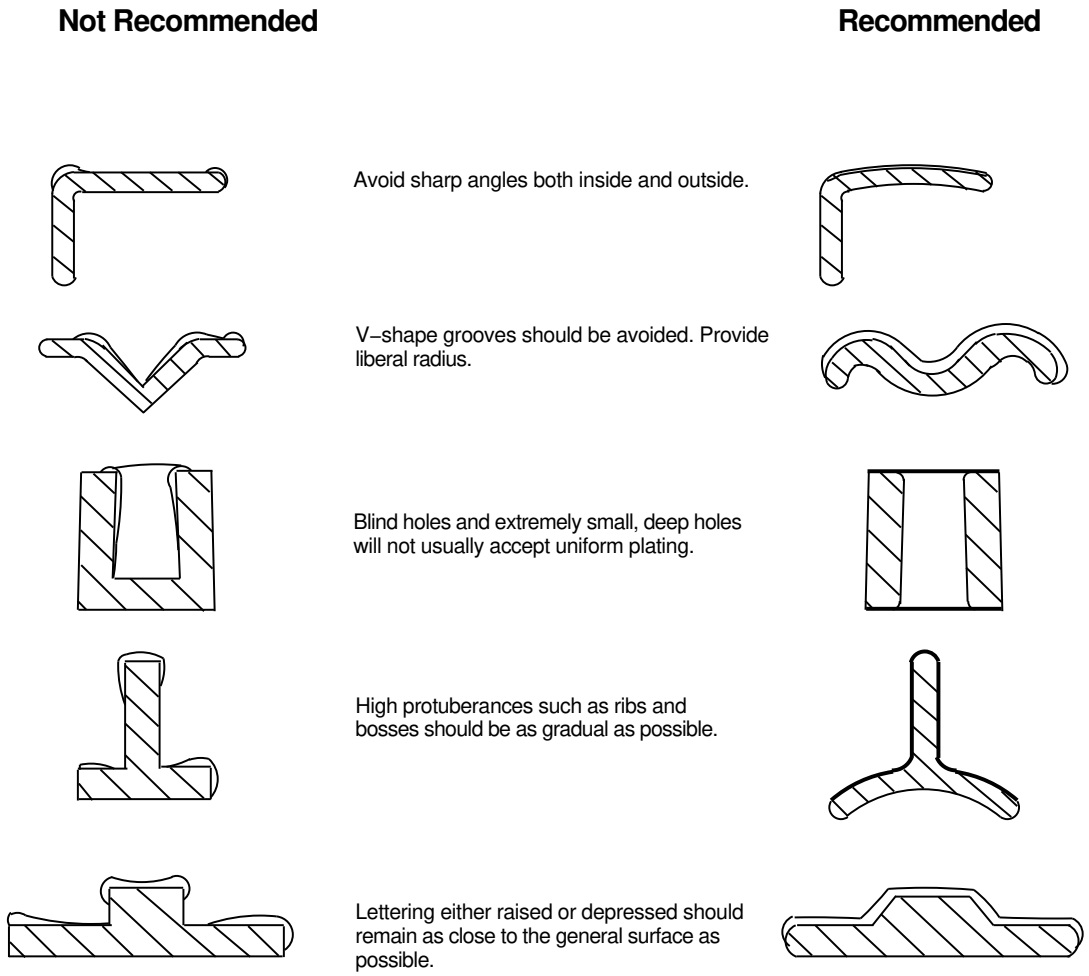
- Irregular surface conditions, closed hems, blind holes, recessed areas, and so on, can result in poor adhesion or non-uniform coating (thickness and coverage). See Figure 2–23.
- Process requires good part drainage characteristics.
- Electrolytic nickel has good electrical surface conductivity.

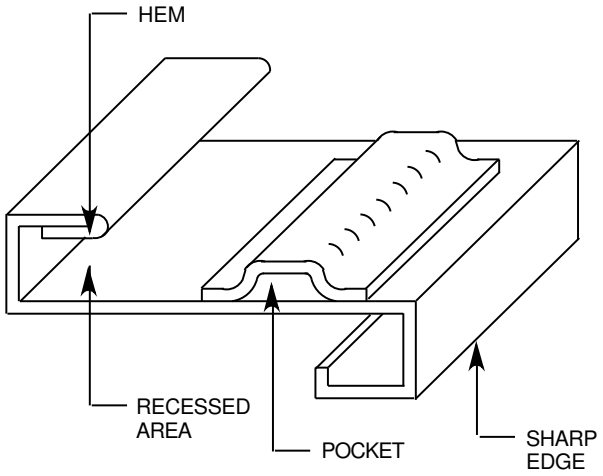
ALTERNATIVE/S:

- Other plating, such as electroless nickel
- Prefinished materials
- Special coatings
- Other base materials, such as stainless steel
- Other processes, such as heat treating
- Paint

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

Figure 2–23: Plate—Nickel (Electrolytic)


Not Recommended
Recommended
Avoid sharp angles both inside and outside.
V–shape grooves should be avoided. Provide liberal radius.
Blind holes and extremely small, deep holes will not usually accept uniform plating.
High protuberances such as ribs and bosses should be as gradual as possible.
Lettering either raised or depressed should remain as close to the general surface as possible.



2.5.10 SPECIAL COATINGS

INFORMATION

RULE/S:

1. Special coatings have been developed to satisfy special abrasion and frictional requirements.
2. Features within the special coating process will be divided into the following categories:
   - Flame/arc spray
   - Topical lubricants
   - Vacuum deposition

   NOTE: Refer to DEC STD 092-0 for more specific information.

REASON/S:

- Conventional painting and plating techniques are more cost-effective methods of providing wearability for sheet metal.
- These feature categories should support most engineering requirements for finishing (wearability) of sheet metal, and will support future AI tool development, for example, The Design Advisor.

ALTERNATIVE/S:

- Prefinished materials
- Other processes, such as, heat treating
- Plating
- Paint
- Other base materials, such as stainless steel

ALTERNATIVE IMPACT: Positive or negative impacts of alternatives, would have to be evaluated based upon specific design requirements. See a Producibility Engineer.

GLOSSARY

artificial intelligence (AI): Intellectual reasoning simulated through the use of computers.

compatible: Two or more materials that can be used in conjunction with one another, without any detrimental effects on any one material or the result of the combination.

corrode: To dissolve or wear away gradually by reaction with the environment.

cosmetic: Pertaining only to appearance qualities.

DEC STD 092-0: *DEC STD 092-0 Finish and Color Standard - Introduction and General Requirements.*

dissolve: To cause to pass into solution.

electroless: Deposition of a metallic coating by a controlled chemical process (in a solution) without the use of an electric current.

electrolytic: Deposition of a metallic coating by a controlled chemical process (in a solution) with the use of an electric current.

EMI: Electromagnetic interference

enamel: A vitrious (glossy), usually opaque, protective or decorative coating baked on metal, glass, or ceramics.

epoxy paint: Any of various usually thermosetting resins, capable of forming tight cross-linked polymer structures characterized by toughness.

etch: To cut into the surface of a substrate by the action of acid or alkaline solutions.

flame/arc spray: A type of thermal spray where the coating metal is melted, atomized, and delivered to the substrate by compressed air or other gasses.

fretting: Wear from small amplitude repetitive motion.

fretting corrosion: A worn spot made by abrasion or erosion, resulting in a corrosive action.

geometry: The basic shape of a part, the relationship between surfaces angles and other aspects.

lacquer: Any of various clear or colored synthetic coatings made by desolving cellulose derivatives together with plasticizers and pigments in a mixture of volatile solvents, and used to give surfaces a gloss.

leveling: The ability of a plating process to equalize surface discontinuities.

line-of-sight: An imaginary line from the eye (source) to the object (substate) being observed.

metal deposition: Any process that deposits a layer of metal on a substrate.

molding: A mechanism required to form thermoplastic or thermosetting materials.

paint: A mixture, usually of a solid pigment in a liquid carrier, used as a decorative or protective coating.

plate: Metal deposited on a substrate, by electrolytic or electroless process.

powder coat: Any paint that is applied to a substrate in a dry solid, powder form, then heated above its melting point to produce a paint film.

prefinished: Any material where the finish is applied prior to part fabrication.

primer coat: Pertaining to painting; a coating required to ensure compatibility between the paint and substrate, such as, adhesion promoting primers.

RFI: Radio frequency interference

shielding: Protection of electronic devices against EMI/RFI emissions.

submersion process: To place or plunge under water or other liquid.

substrate: The base material.

texture: The representation of the structure of a surface as distinct from color or form.

urethane: Any of various thermoplastic or thermosetting resins, widely varying flexibility, used in tough chemical-resistant coatings.

vacuum deposition: The process of depositing metals, by a source evaporating in a high-vacuum environment onto a substrate, such as , vacuum deposition of aluminum.

water-borne: A liquid paint using water as the carrier.

wear: Removal of material from a solid surface as a result of mechanical actions.

wearability: The ability of a material to withstand damage or degradation through extended use.

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